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AN ANNOTATED BIBLIOGRAPHY OF INTERSPECIFIC HYBRIDIZATION OF SALMONIDAE

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PREPARATION OF THIS DOCUMENT

This bibliography is an attempt by the author to include all known literature, published and unpublished, on hybridization in Salmonidae. The whitefishes and graylings are considered by the author as separate families and are not included. The author would appreciate being informed of any references to salmonoid hybrids known to the reader that are not included in this bibliography, as well as corrections or additions to the annotations, so that they may be included in future revisions or addenda.

Articles not obtained for review are included but not annotated unless referred to in other sources. When abstracts or summaries pertaining to hybridization were included in papers, they have been transcribed in quotation marks verbatim, as are certain passages of text when applicable. Unless otherwise cited, the abstracts were written by the author.

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FAO Fisheries Circular (FAO Fish.Circ.)

A vehicle for distribution of short or ephemeral notes, lists, etc., including provisional versions of documents to be issued later in other series.

Ackermann, K. (1898) 001
Abh.Ber.Ver.Naturkd.Kassel, 43:4-11
Thierbastarde. Zusammenstellung der bisherigen Beobachtungen über Bastardirung im Thierreiche nebst Litteraturnachweisen. 2. Theil: Die Wirbelthiere (Fische)

Alabaster, J.S., and F.J. Durbin (1965) 002
Rep.Salmon Res.Trust Irel., (1964):38-9
Blood groups in salmon, trout and their hybrids

Serological research work on the blood groups of salmon, trout and their hybrids suggest regional differences in the blood groups of Atlantic salmon and trout and also provide circumstantial evidence for the inheritance of blood groups in the hybrids.

Ali, M.A. (1964) 003
Can.J.Zool., 42(6):1158-60
Retina of the albino splake (Salvelinus fontinalis X S. namaycush)

Examination of the retina of albino splake with photomicrographs. Specimens from the Eastern Townships Hatchery of the Quebec Department of Game, Fisheries, and Tourism.

Allan, W. (1953) 004
North.Sportsman, 18(12):23
Will there be a splake lake too?

According to Martin (1960), "General popular account of recent history and potential as a game fish."

Alm, G. (1955) 005
Rep.Inst.Freshwat.Res.Drottningholm, (36):13-56
Artificial hybridization between different species of the salmon family

A quite complete study of hybridizing Salmo salar, S. trutta, Salvelinus alpinus, and S. Fontinalis. An excellent review of previous literature. Alm found that the S. alpinus X S. fontinalis hybrid of greater value than the other hybrids.

Alm, G. (1959) 006
Rep.Inst.Freshwat.Res.Drottningholm, (40):5-145
Connection between maturity, size and age in fishes

Salmo salar and S. trutta hybrids and Salvelinus fontinalis and S. alpinus hybrids used in the study.

Alm, G. (1961) 007
Rep.Inst.Freshwat.Res.Drottningholm, (42):5-83
Die Ergebuisse der Fischaussätze in den Mälarne-Seen (with English summary)

Planting of S. salar X S. trutta, S. alpinus X S. trutta, and S. alpinus X S. fontinalis hybrids in lakes near Mälarne in productivity studies.

American Fish Farmer (1970) 008
Am.Fish Farmer, 1(5):27
Russians breed salmon on Sakhalin. In World aquaculture news

Brief mention of hybrid of Siberian (Oncorhynchus keta) and humpback (O. gorbuscha). The hybrid fish has not only the weight and taste of the Siberian salmon but the quick growth of the humpback salmon.

Andreeva, M.A. (1953) 009
Rybn.Khoz., (11)
Experiments in the hybridization of Pacific salmon

According to Smirnov (1969), Andreeva considers Oncorhynchus nerka X O. keta hybrids in Ushkovsky Lake natural. Smirnov believes them to be artificial hybrids.

Andreeva, M.A. (1954) 010
Tr.Sovesch.Ikhtiol.Kom.Akad.Nauk SSSR, 4:70-7
Fish-cultural and fish protective measures for the maintenance and propagation of salmonoid fishes in Kamchatka waters. Issued also as Transl.Ser.Fish.Res.Board Can., (420)(1962)

At the hatchery experiments were carried out on the cross-breeding of different species of salmon. The purpose of the experiments were to obtain hybrids which would be hardier than the sockeye and would inherit the age at maturity and body size of chums and the excellent flavour, quality and the fecundity of the sockeye. In 1948, for the first time, viable fry were obtained from crossing sockeye females and chum males.

Arakie, D.H. (1969) 011
Brooklyn, N.Y., 6 p.
Arakie's fishery blue book

Smirnov in 1953 developed and described a hybrid between the chum and pink salmons of the Pacific Ocean. He noted that these hybrids showed a shorter period of incubation, a more complete hatch, and faster growth in length and weight of the fry. The splake, a hybrid resulting from the cross of the eastern brook trout (Salvelinus fontinalis), and the lake trout (Salvelinus namaycush), was described by Buss and Wright in 1959.

Arens, C. (1894) 012
Allg.Fisch.-Ztg., 19:346-7
Ueber den Lachsbastard

According to Dean (1962), infertile Salmo trutta (fario) X S. salar at Hüningen, Alsace.

Arens, C. (1893) 013
Allg.Fisch.-Ztg., 18:148-9
Bastarde zwischen Forelle und Bachsaibling

According to Dean (1962), Salmo trutta (fario) X Salvelinus alpinus (salvelinus).

Atz, W. (1971) 014
New York, American Museum of Natural History, 512 p.
Dean bibliography of fishes 1968

Lists hybrids.

Bailey, M., et al. (1970) 015
Spec.Publ.Am.Fish.Soc., (6):17 p.
A list of common and scientific names of fishes from the United States and Canada

Hybrids between brook trout (Salvelinus fontinalis) and lake trout (Salvelinus namaycush) are known as splake.

Baird, S. (1873) 016
Ann.Rec.Sci., 1873-75:442
Hybrids of salmon and trout

According to Dean (1962), misc. and unimportant.

Bakkala, G. (1970) 017
FAO Fish.Synop., (41):89 p.
Synopsis of biological data on the chum salmon, Oncorhynchus keta (Walbaum) 1792
Issued also as Circ.U.S.Fish.Wildl.Serv., (315):89 p.

Brief review of most hybridization of chum.

Baldwin, N.S. (1965) 018
Sylva, 12(3):6-9
Hybrid trout

A fair account of splake in Canada with data on appearance, habits, and plantings in Ontario.

Bean, T.H. (1889) 019
For.Stream, 33:321
Crossing of salmon and trout

Bean, T.H. (1889a) 020
Bull.U.S.Fish Comm., 7(1887):216
A hybrid between the lake trout and brook trout

Description of hybrids of Salvelinus namaycush and S. fontinalis from Corry Station, Pennsylvania Fish Commission.

Bean, T.H. (1889b) 021
Trans.Am.Fish.Soc., 18:12-20
Hybrids in Salmonidae

Reviews an account in The American Angler of a supposed cross between Salmo gairdneri ♀ X Salvelinus fontinalis ♂. Fish of unknown origin from Wytheville, Virginia. Morphometric and meristic data on hybrid. A more complete report of Bean (1889a) is presented on hybrids of S. namaycush and S. fontinalis.

Bean, T.H. (1889c) 022
For.Stream, 31:520
Lake and brook trout hybrid

According to Dean (1962), Salvelinus fontinalis X S. namaycush at Corry Station Pennsylvania.

Bean, T.H. (1889d) 023
For.Stream, 32:401
Saibling and brown trout hybrid

According to Dean (1962), Salmo trutta (fario) X Salvelinus alpinus (umbla) hybrid received at U.S. National Museum from Norway.

Bean, T.H. (1890) 024
For.Stream, 35:377
A supposed hybrid trout

According to Dean (1962), Salvelinus fontinalis X S. namaycush hybrid at Corry Station, Pennsylvania.

Bean, T.H. (1910) 025
For.Stream, 35:429
Is the golden trout a hybrid?

Bean, T.H. (1910a) 026
For.Stream, 35:353
A new hybrid trout

According to Dean (1962), Salvelinus fontinalis X S. alpinus aureolus at Sunapee Lake hatchery with fertile hybrid.

Behnke, R.J. (1966) 027
Copeia, 1966 (2):346-8
Relationships of the far eastern trout, Salmo mykiss Walbaum

I suspect that mykiss and gairdnerii, if crossed, would prove to be fully fertile and might properly be considered only subspecies.

Behnke, R.J. (1968) 028
Mitt.Hamb.Zool.Mus.Inst., 66:1-15
A new subgenus and species of trout, Salmo (Platysalmo) platycephalus, from south-central Turkey, with comments on the classification of the subfamily Salmonidae

Salmo marmoratus Cuvier freely hybridizes with Salmo trutta producing hybrid swarms. (Numann, 1964).
Natural hybrids of Brachymystax lenok and Hucho taimen from the Amur River system in China (Se, Huan, and Yuan, 1959).

Behnke, R.J. (1969) 029
Proc.West.Assoc.Game Fish Comm., 48:533-5 (Mimeo reprint)
Rare and endangered species: the native trouts of western North America

Introductions of rainbow trout into interior waters where only the cutthroat trout is native, and subsequent hybridization between the two, has been a major factor in the decline of populations of native interior cutthroat trout.

Behnke, R.J. (1970) 030
Trans.Am.Fish.Soc., 99(1):237-48
The application of cytogenetic and biochemical systematics to phylogenetic problems in the family Salmonidae

When rainbow trout are introduced into cutthroat trout populations in interior waters where rainbow trout is not native, hybrid swarms are the typical result.

Behnke, R.J. (1970a) 031
Rep.Colo.Coop.Fish.Unit.Colo.State Univ.
12 p. (Unpubl.MS)
Rare and endangered species report: new information on gila trout, Salmo gilae

Hybridization with introduced rainbow trout is the major reason for the almost complete elimination of pure populations of S. gilae. Hybrids may be recognized by the intermediacy of several characters such as spotting pattern, number of scales, vertebrae and pyloric caeca and some morphometric comparisons.

Reciprocal crosses of Salmo trutta and Salvelinus alpinus are described from Norway.
It is suggested that Green (1881) possibly made a mistake in his crosses of S. fontinalis with Oncorhynchus tshawytscha and Salmo gairdneri. Behnke's examination of specimens sent by Green to the Smithsonian Institution resulted in no difference between the two crosses.

Behnke, R.J., Ting Pong Koh and P.R. Needham (1962) 032
Copeia, 1962(2):400-7
Status of the landlocked salmonid fishes of Formosa with a review of Oncorhynchus masou (Brevoort)

Russians have been experimenting with Oncorhynchus keta X O. gorbuscha hybrids.

Behrens, G. (1885) 033
Biol.Zentralbl., 1885-86, 5:639-40
Die Hybridisation von Salmoniden

According to Dean (1962), notice of Day's work.

Bellesmes, J. de 034
La pisciculture en france. p. 168

According to Phillips (1923) quoting Richmond (1919), "In France, Dr. Joussell de Bellesmes, Director of Fish-culture in Paris states (La Pisciculture en France, p. 168) that he obtained a successful cross at the Trocadero Aquarium in Paris on 3rd February, 1890, getting eight hundred ova which survived and developed satisfactorily, the majority of the hybrids resembling rainbow trout in outward appearance. Two of them lived in the aquarium till 1897, and grew to a good size, reaching a length of 85 cm, when in that year they spawned and died. It is curious that Dr. de Bellesmes has found a similar delay in arrival at sexual maturity in the cross, which is easily made, between the American brook-char and the brown trout, the hybrid from which in this country has usually been regarded as sterile."
Phillips and Richmond were concerned with hybrids of Salmo trutta and S.gairdneri.

Berst, A.H., and G.R. Spangler (1970) 035
J.Fish.Res.Board Can., 27(6):1017-32
Population dynamics of F splake (Salvelinus fontinalis X S. namaycush) in Lake Huron

Planted F_1 splake tended to remain in the general vicinity of the planting sites. They fed upon smelt and alewives, which are presently abundant in Lake Huron. The hybrids grew more rapidly at ages I through VIII than native and planted lake trout and contributed to a commercial fishery within 2 years of planting. A considerable number of splake survived to maturity in the presence of an intensive commercial fishery and a lamprey population that was unaffected by chemical control. We believe that these attributes of splake will be preserved and enhanced in a stock of hybrids selected through several generations for early maturity.

Bonham, K., and A.H. Seymour (1949) 036
Copeia, 1949 (2):69
Hybrid of chinook and silver salmon from Puget Sound

Morphometric and meristic data for a natural hybrid of Oncorhynchus kisutch and O. tshawytscha. Also report of natural cross-mating observed by Mr. Elmer Quistorff, Superintendent of the Washington State Department of Fisheries Issaquah Salmon Hatchery.

Bouck, G.R., and R.C. Ball (1968) 037
J.Fish.Res.Board Can., 25(7):1323-31
Comparative electrophoretic patterns of lactate dehydrogenase in three species of trout

The total number of LDH isozymes in tissue extracts of brook-brown trout (F_1) hybrids were difficult to assess but showed essentially the same number of LDH isozyme systems as did the parent types. The outstanding difference in the hybrid specimens was that the total number of isozymes rose markedly within a given system.
Also, a given isozyme system occupied essentially the same space but it contained so many isozymes that the total number could not be counted accurately. At least 27 were counted in the extracts of one hybrid specimen but only 25 were counted in the other specimens. These numbers must be viewed as representing minimum counts.

Brown, B.E. (1961) 038
Trans.Am.Fish.Soc., 90(3):328-9
Behavior of splake and brook trout fingerlings

In these observations domesticated trout behaved exactly as in previous tests carried out by Vincent (1960). Splake, however, showed a contrasting behavior in all trials attempted. In this respect they resembled the wild brook trout observed by Vincent in having a well-developed hiding reaction, a tendency to seek depths, and negative phototropism. The latter trait is characteristic of young lake trout reared in New York hatcheries. It is concluded that the responses of this domesticated stock of brook trout relative to these traits were not transferred to the F_1 hybrid.

Brown, C.J.D. (1966) 039
Copeia, 1966(3):600-1
Natural hybrids of Salmo trutta X Salvelinus fontinalis

Morphometric and meristic data for three natural "tiger" trout from Montana.

Fertile hybrids found among the fish tested were splake (lake trout X brook trout) and the backcross progeny of splake X brook trout. Limited fertility was found in one 'tiger' trout male (brown trout female X brook trout male) and in nine yearling males originating from crosses of rainbow trout females X brook trout males. These fertile individuals have been backcrossed to the parental species with limited results to date.

Brown, E.E. (1970) 040
Prog.Fish-Cult., 32(1):8
Hybrid vigor reported

Description of "rainbows" produced at the Eagle Mountain Trout Farm in Georgia by crossing Salmo trutta females with S. gairdneri males.

Bruyant, C. (1910) 041
Ann.Stn.Limnol.Besse, 2:125-33
Hybrides de truite et d'omble-chevalier

According to Dean (1962), Salmo trutta (fario) X Salvelinus alpinus (umbla) in France.

Budd, J.C. (1957) 042
Can.Fish Cult., 20:25-8
Introduction of the hybrid between the eastern brook trout and lake trout into the Great Lakes

Marked yearling hybrids between eastern brook trout and common lake trout were planted in South Bay in northern Lake Huron in the spring of 1954. Growth was rapid and after one year in the lake the hybrids averaged 13.9 inches in fork length. A number of the fish were tagged and subsequent recapture data recorded. Seven tags were returned from distances up to 100 miles. Two of the tagged fish had entered streams while the other five were taken by commercial gear. Ripe male hybrids were taken in South Bay during late October and early November.

Budd, J.C. (1959) 043
Trans.Northeast.Wildl.Conf., 10:115-6
The use of the hybrid between eastern brook trout and lake trout in fishery management

According to Carlander (1969), concerns splake.

Burkhard, W.T. (1961) 044
Q.Rep.Colo.Coop.Fish.Res.Unit, (7):41-52
Life history of the splake trout - Parvin Lake

Burkhard, W.T. (1962) 045
Thesis, Colorado State University, Fort Collins, 91 p. (Unpubl.MS)
A study of the splake trout in Parvin Lake, Colorado.

The present study has followed Leik's (MS, 1960) and has expanded on his material and included two new age groups not previously available for study. With the inclusion of 3- and 4- year-old fish, the important aspects of splake trout maturation and reproduction were included.

Burrard, G. (1944) 046
Game Gun Anglers Mon., Nov. issue
The hybridization of trout.

Buss, K. (1956) 047
Pa.Angler, 25(5):2-7
The splake

A popular account of published data on splake and discussion of work at the Benner Springs Research Station.

Buss, K., and J. Miller (1967) 048
Tech.Pap.Bur.Sport Fish.Wildl., (14):1-30
Interspecific hybridization of Esocids: hatching success, pattern development, and fertility of some F_1 hybrids

Very brief mention of hybridization in Salmonidae.

Buss, K., and J.E. Wright, Jr. (1956) 049
Prog.Fish-Cult., 18(4):149-58
Results of species hybridization within the family Salmonidae

A preliminary but comprehensive report of hybridization of Salmo salar sebago, S. trutta, S. gairdneri, Salvelinus namaycush, and S. fontinalis. See Buss and Wright (1958).

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Buss, K., and J.E. Wright, Jr. (1958) 050
Trans.Am.Fish.Soc., 87:172-81
Appearance and fertility of trout hybrids

Mature hybrids among brook trout (Salvelinus fontinalis), brown trout (Salmo trutta), rainbow trout (Salmo gairdneri), and lake trout (Salvelinus namaycush) involving reciprocal crosses, backcrosses and three-way crosses were utilized to test fertility and to present photographic records of external characteristics.
Fertile hybrids found among the fish tested were splake (lake trout X brook trout) and the backcross progeny of splake X brook trout. Limited fertility was found in one 'tiger' trout male (brown trout female X brook trout male) and in nine yearling males originating from crosses of rainbow trout females X brook trout males. These fertile individuals have been backcrossed to the parental species with limited results to date.

Camp, R.R. (1953) 051
New York Times
December 1953

According to Martin (1960), "General comments on hybrid trout. Critical of hybrid and principle of hybridization."

Canada, Minister of Game and Fisheries, Province of Quebec (1947) 052
General report of the Minister of Game and Fisheries for year ended March 31, 1946

According to Martin (1960), "700 hybrid fingerlings (splake) planted in 1944 from Baldwin Mills Hatchery."

Carl, G.C., W.A. Clemens and C.C. Lindsey (1959) 053
Handb.B.C.Prov.Mus., (5):70 p.
The fresh-water fishes of British Columbia

Cutthroat and rainbow which occur naturally together do not often hybridize and are probably kept apart by differences in behaviour rather than by physical inability to cross. On the other hand, in areas which originally contained only one of the species, the artificial introduction of the other often results in extensive hybridization and the production of offspring combining characters of both parents. Such hybrids were at one time produced deliberately and planted in certain waters in the Cranbrook area. These trout were referred to as 'Cranbrook trout'.

Carlander, K.D. (1969) 054
Ames, Iowa, Iowa State Univ.Press, vol.1:752 p.
Handbook of freshwater fishery biology

Lists trout hybrids.

Chamberlain, F.M. (1907) 055
Rep.U.S.Bur.Fish.Doc., (627):10-1
Hybridization. In Some observations on salmon and trout in Alaska

Discusses the question of natural hybrids of trout and of salmon, and mentions the latter in commercial catches.

https://archive.org/details/fao-fisheries-and-aquaculture-circular_1973-09_133

Christie, W.J. (1960) 056
Can.Fish Cult., 26:15-21
Variation in vertebral count in F_2 hybrids of Salvelinus fontinalis X S. namaycush

The wide range of vertebral number in this sample and perhaps also the range in size, appear to be good evidence of normal pairing of chromosomes and subsequent segregation in the F_2 generation. ... We can therefore tentatively conclude that the splake is a true hybrid, from recently evolved parent species, and selection for desirable characters to produce a new form is theoretically possible.

Christie, W.J. (1970) 057
Res.Inf.Pap.Ont.Dep.Lands For., (370):14 p.
A review of the Japanese salmons Oncorhynchus masou and O. Rhodurus with particular reference to their potential for introduction into Ontario waters

Oshima (1957) demonstrated in hybridization experiments that the red spots of O. rhodurus are genotypic, and recessive to the O. masou coloration.

Clemens, W.A. (1953) 058
Trans.R.Soc.Can., (3),47(5):1-13
On some fundamental problems in the biology of Pacific salmon

That the separation of the species (of Oncorhynchus) may have been of comparatively recent date is indicated by the fact that cross-breeding is possible, as shown by the cross-fertilization experiments carried out by Foerster (1935).

Collins, J.W. (1892) 059
Rep.U.S.Fish.Comm., (1888):3-269
Report on fisheries of the Pacific Coast of the United States

An unreliable report of a hybrid (not classified) from the Columbia River is included in a list of the names of 12 salmon. This matter is referred to in order to remove a quite common error.

Cope, O.B. (1956) 060
Proc.Utah Acad., 32:89-93
The future of the cutthroat in Utah

According to Carlander (1969), S. gairdneri X S. clarki hybridization is a factor threatening cutthroats in Utah.

Crettiez, J. (1906) 061
C.R.Assoc.Fr.Av.Sci., 35(119):498-506
Sur la culture de l'ombre-chevalier (Salvelinus umbla L.) du Leman à l'établissement de pisciculture de Thonon. Metis et hybrides de ce salmonide.
Issued also as Bull.Suisse Pêche Pisci., 8(4-7):26-9

According to Dean (1962), Salmo gairdneri ♀ X Salvelinus alpinus (umbla) ♂ and Salmo trutta (fario) X S. alpinus (umbla) in France.

Crossman, E.J., and K. Buss (1966) 062
Copeia, 1966(2):357-9
Artificial hybrid between kokanee (Oncorhynchus nerka) and brook trout (Salvelinus fontinalis)

The two S. fontinalis female X O. nerka male individuals described were the only survivors of two attempts to produce hybrids from kokanee and brook, brown, and rainbow trout (reciprocal crosses).

Cuerrier, J.P. (1954) 063
For.Outdoors, (May):17-8
The splake: this trout is a great fighter!

Review of Stenton (1950 and 1952).
F2 splake planted in Agnes Lake, Banff National Park (Alberta) in 1953

Day, F. (1882) 064
Proc.Zool.Soc.Lond., 1882:751-3
On hybrids between salmon and trout

Early report of hybrids of Salmo salar, S. trutta, Salvelinus fontinalis, and S. alpinus.

Day, F. (1882a) 065
J.Linn.Soc.Lond.(Zool.), 17:13-9
On variations in form and hybridism in Salmo fontinalis.

Day, F. (1884) 066
Proc.Zool.Soc.Lond., 1884:17-40, 376-80, 581-93
On races and hybrids among the Salmonidae. Part 1-3
Issued also as: Am.Nat., 18:1158-60

Continuation of Day (1882) with additional crosses and backcrosses.

Day, F. (1884a) 067
Nature, Lond., 30:488
Salmon breeding

Day, F. (1885) 068
Nature, Lond., 31:599-600
Hybridization among Salmonidae

Day, F. (1885a) 069
Proc.Zool.Soc.Lond., 1885:241-3
On races and hybrids among the Salmonidae Part 4.

Additional data on Day (1884).

Day, F. (1885b) 070
Trans.Linn.Soc.Lond.(Zool.), 2(15):447-68
On the breeding of salmon from parents which have never descended to the sea

Mention of Day's earlier papers.

Day, F. (1886) 071
Rep.Br.Assoc.Adv.Sci., 55:1059-63
On the hybridisation of Salmonidae at Howietoun

Summary of Day's earlier reports. Review of earlier hybridization without references.

Day, F. (1887) 072
London, Williams and Norgate, 298 p.
British and Irish Salmonidae

Review and discussion of Day's earlier reports.

Day, F. (1888) 073
Proc.Zool.Soc.Lond., 3
Exhibition of, and remarks upon, a specimen of the Spanish loach (Cobitis toenia) and of some hybrid Salmonidae

Day, F. (1890) 074
Fish.Proc.Cotteswold Nat.Field Club, 9:334-73
Notes on hybridization

Dean, B. (1962) 075
New York, Russell and Russell Inc. 3 vols. Reprint of Vol.1,1916, Vol.2,1916, Vol.3,1923
A bibliography of fishes

Brief abstracts on many old references

Duff, D.C.B. (1933) 076
Trans.Am.Fish.Soc., 62:249-55
Furunculosis on the Pacific coast

An outbreak of the epizootic in British Columbia was noted among three year old hybrids of Oncorhynchus nerka and O. keta.

Duff, D.C.B. and B.J. Stewart (1933) 077
Contrib.Can.Biol.Fish., 8:103-22
Studies on furunculosis of fish in British Columbia

According to Foerster (1968) there was one instance of furunculosis reported for British Columbia, at the Smith Falls hatchery rearing ponds, Cultus Lake, where Foerster's (1935) artificially produced Oncorhynchus hybrids were being retained to maturity.

Duke, E. (1970) 078
Contribution to 6th Annual meeting, Freshwater Research Group, Dublin

Dunbar, C.E. (1969) 079
Natl.Cancer Inst.Monogr.31:167-71
Lymphosarcoma of possible thymic origin in salmonid fishes

Because of the cytologic similarities between the tumors in brook trout and in splake, and because such tumors have not been reported in lake trout, it seems likely that a predisposition of splake to develop thymic lymphoma is genetically transmitted from the brook trout.

Dvinin, P.A. (1953)
Rybn.Khoz., 5
Experiments in the artificial feeding of young salmon and their hybrids

According to Smirnov (1969), hybrids of Oncorhynchus masou and O. gorbuscha.

080 In two Algonquin Park lakes thermal stratification varied considerably in depth and constitution in the different years, but the thermal position of the splake (Salvelinus namaycush ♀ X S. fontinalis ♂ remained similar.

Dymond, J.R. (1932)
Bull.Fish.Res.Board Can., 32:35 p.
The trout and other game fishes of British Columbia

081 Fertile hybrids were produced at the Cranbrook hatchery (British Columbia) from Salmo gairdneri and S. clarki. F_2 fry were raised in 1927 and 1928.

Eipper, A.W. (1955)
Typewritten job completion report, Dingell-Johnson Project F-4-R-3.
Investigation of farm fish ponds and bait ponds in New York State (Unpubl.MS)

082 According to Buss and Wright (1956), hybrids of Salvelinus namaycush ♀ X S. fontinalis ♂ and S. fontinalis ♀ X Salmo gairdneri ♂.

Eipper, A.W. (1964)
Mem.Agric.Exp.Stn.Cornell Univ., (388):67 p.
Growth, mortality rates, and standing crops of trout in New York farm ponds

083 According to Carlander (1969), Salmo gairdneri X S. trutta failed to survive to fry stage at Cornell and Benner Springs Hatcheries. Salvelinus fontinalis X S. gairdneri failed at Cornell but one batch showed 0.6% survival at Benner Springs. Also tiger and splake.

Fabricus, E. (1953)
Rep.Inst.Freshwat.Res.Drottningholm, (34):14-48
Aquarium observations on the spawning behaviour of the char

084

Ferguson, R.G. (1958)
J.Fish.Res.Board Can., 15(4):607-24
The preferred temperature of fish and their midsummer distribution in temperate lakes and streams

085

Fehlmann, W. (1926)
Jahresber.Kant.Schaffhausen, 1926:1-112
Die Ursachen des Ruckganges der Lachsfischerei im Hochrhein

086 Alm (1955) reports that in the Rhine as early as the latter half of the 19th century hybridization between S. salar and S. trutta was regularly carried out in connection with salmon hatching. This often occurred because male salmon were not available in sufficient quantities, but also for the purpose of combining certain good qualities in the parents which was, however, not successful. During the years 1918-1922 Fehlmann (1926) carried out new experiments and reared the hybrids in ponds to an age of 3 years. The majority were then sexually mature and attempts were made to obtain an F2 generation. Mortality before the fry stage was however 100%.

Fish Commission of Oregon (1970)
Ann.Rep.Fish.Comm.Ore.Fish Cult.Div. Hatchery Biol.Sec., 1970:3-4
Cooperative studies (MS)
In Development and improvements of hatchery techniques for Pacific salmon and steelhead trout.

087 Results of preliminary studies on hybrid salmon indicate that crosses between chinook males and pink or chum females produce viable fry which adapt quickly to full-strength sea water. Early indications from this would suggest that hybrid salmon exhibit good growth in sea water during early juvenile stages.

Fisheries Research Board of Canada (1967)
Rev.Fish.Res.Board Can., 1965-66:94
Sockeye and pink salmon hybrids

088 Brief mention of the crosses

Fisheries Research Board of Canada (1969) 089
Rev.Fish.Res.Board Can., (1965-66):5
Salmon hybrids

Brief mention of pink and sockeye, sockeye and chum hybrids.

Fitzinger, L.J.F.J. (1875) 090
Sitzungber.Akad.Wiss.Wien(Math.-Nat.), 70(1):394-400
Bericht über die an den oberösterreichischen Seen und in den dortigen Anstalten für kunstliche Fischzucht gewonnenen Erfahrungen bezüglich der Bastardformen der Salmonen

Fitzinger, L.J.F.J. (1875a) 091
Zool.Gart., Frankf.A.M., 16:156-7
Sind Fischbastarde fruchtbar? (Abstr.)

Fitzinger, L.J.F.J. (1876) 092
Sitzungber.Akad.Wiss.Wien(Math.-Nat.), 72(1):235-40
Bericht über die an den Seen des Salzkammergutes, Salzburgs und Berchtesgadens gepflogenen Nachforschungen über die Natur des Silberlachses (Salmo schiffermülleri Bloch)

Flick, W.A. and D.A. Webster (1964) 093
Trans.Am.Fish.Soc., 93(1):58-69
Comparative first year survival and production in wild and domestic strains of brook trout, Salvelinus fontinalis

Some splake backcrossed to female brook trout used in study.

Foerster, R.E. (1930) 094
Prog.Rep.Pac.Biol.Stn.Nanaimo, (6):6-8
The hybridization of salmon

First report of hybridization at Cultus Lake. See Foerster (1935).

Foerster, R.E. (1935) 095
Trans.R.Soc.Can., (3):29, (5):21
Inter-species cross-breeding of Pacific salmon

The first comprehensive study on all five species of North American Oncorhynchus. Reciprocal crosses made and some backcrosses and F_2 hybrids. Literature review.

Foerster, R.E. (1955) 096
Bull.Int.North Pac.Fish.Comm., (1):1-56
The Pacific salmon (genus Oncorhynchus) of the Canadian Pacific coast, with particular reference to their occurrence in or near fresh water

Brief mention of Foerster (1935).

Foerster, R.E. (1968) 097
Bull.Fish.Res.Board Can., (162):422 p.
The sockeye salmon, Oncorhynchus nerka

Review of Foerster (1935), Russian hybridization, and possibilities of selective crossbreeding of salmon.

Fowler, H.W. (1944) 098
Bienn.Rep.Pa.Board Fish.Comm., 1941-2:55-63
The salmon-like fishes of Pennsylvania

According to Brown, C.J.D. (1966), Fowler describes 2 dwarf brown trout which Brown recognizes as hybrids.

Fraas, C.N. (1854) 099
München, 2nd ed.
Die künstliche Fischerzeugung nach den Erfahrungen der künstliche Fischzucht-Anstalt der General-Comité des Landwirthschaftliche Vereins von Bayern.
(Abstracted in Dean, 1962)

Hybrid of Salmo trutta (fario) X Lota marmorata.

Fry, F.E.J. and M.B. Gibson 100
J.Hered., 44(2):56-7
Lethal temperature experiments with speckled trout X lake trout hybrids

Fujita, T. (1926) 101
Dobutsugaku Zasshi, 38(488):39-51
Issued also as Transl.Ser.Fish.Res. Board Can., (1062)
On the characteristics of hybrids (F_1) among Japanese salmon and trout

Reciprocal crosses between Oncorhynchus keta, O. masou, and O. gorbuscha. The hybrid of O. masou female X O. keta male was the only cross not described and discussed fully beyond the fry stage.

Garside, E.T. and F.E.J. Fry (1959) 102
Can.J.Zool., 37(4)
A possible relationship between yolk size and differentiation in trout embryos

According to Martin (1960), reciprocal crosses of Salvelinus namaycush and S. fontinalis yolk sac size limited myomere number counts

Gaylord, H.R. (1910) 103
J.Am.Med.Assoc., 54(3):227
An epidemic of carcinoma of the thyroid gland among fish

Gaylord and Marsh (1912) record that "Another observation of importance is the discovery that lots of fish are immune. This is particularly shown in hybrid fish, in which one lot of hybrid salmon 1 year old were reduced from 1,043 in April to 44 sound fish remaining in August, whereas another lot of yearling hybrid salmon, although badly exposed by being placed in ponds into which the water from infected ponds ran, remained free from the disease throughout."

Gaylord, H.R. and M.C. Marsh (1912) 104
Bull.U.S.Bur.Fish., 32:363-524
Carcinoma of the thyroid in the salmonoid fishes

Hybrids of Salvelinus fontinalis female X Salmo salar sebago and S. fontinalis female X S. aureolus (alpinus) male reported hardy (mature) and exhibit some immunity to tumor formation. Hybrids of Oncorhynchus kisutch♀ X O. gorbuscha♂, O. kisutch♀ X O. tschawytscha♂, O. nerka♀ X O. gorbuscha♂, and O. gorbuscha♀ X O. nerka♂ were not hardy and were highly susceptible to tumour formation.

Gibson, R. (1929) 105
Rep.Commer.Fish.Prov.B.C., 1928:50-2
The spawning-beds of the Skeena River

An unusual incident was noticed by Mr. Hearne - a female pink spawning with a male sockeye. This female chased the males of its own species away in order to spawn with the sockeye. At the time there was no scarcity of male pinks or female sockeye.

Gilmour, W.M. (1950) 106
Thesis, University of Alberta, Edmonton. 59 p.
A study of the Lower Bow River trout with special reference to taxonomy (Unpubl. MS)

Neither the native Salmo clarki nor the introduced S. gairdneri seem to be present in the Bow River as a true species. This leads to the supposition that the Bow River trout is a hybrid between the rainbow and the cutthroat.

Goldberg, E. (1966) 107
Science, N.Y., 151(3714):1091-3
Lactate dehydrogenase in trout: hybridization in vivo and in vitro

Speckled trout and lake trout contain five forms of lactate dehydrogenase, but a different electrophoretic distribution of isozymes characterizes each species. The hybrid splake, which is produced artificially by fertilizing lake trout eggs with speckled trout sperm, contains nine isozymes. This complement of isozymes in vivo could be produced in vitro by recombination of subunits from tissues of the parent species. In the splake trout, this complement is the result of heterozygosity at the gene locus responsible for synthesis of LDH-5. Extracts of trout eyes contain at least two additional forms of LDH which could not be demonstrated in other tissues.

Goldberg, E., J.P. Cuerrier and J.C. Ward (1967) 108
Nat.Can., 94:297-304
Lactate dehydrogenase isozymes, vertebrae and caeca numbers in an isolated, interbreeding population of splake trout

Distribution of lactate dehydrogenase (LDH) isozymes genotypes has been studied with an isolated population of splake trout.
LDH genes have been shown to be evolutively stable. However, this genetic equilibrium does not seem to apply to the total gene pool since determination of pyloric caeca and vertebrae numbers does not show such a stability.

Goldberg, E., J.P. Cuerrier and J.C.Ward (1969) 109
Biochem.Genet., 2:335-50
Lactate dehydrogenase ontogeny, paternal gene activation, and tetramer assembly in embryos of brook trout, lake trout, and their hybrids

Measurement of lactate dehydrogenase in reciprocal hybrids of trout during development revealed that a maternal effect was involved in the regulation of enzyme levels until resorption of the yolk sac was complete.
Malate dehydrogenase specific activities were the same in these embryos and larvae. Activation of the paternal A gene in reciprocal hybrids occurred at a relatively late stage with the LDH subunit specific to the retina appearing after hatching.

Green, S. (1879) 110
For.Stream, 13:885
Hybrid trout

Green, S. (1880) 111
For.Stream, 15:366
Fertile hybrids

Green, S. (1880) 112
Chic.Field, 14:284
Hybrid trout

Green, S. (1881) 113
Trans.Am.Fish Cult.Assoc., 10:5-9
Hybridizing fishes

Fertile hybrids of Salvelinus fontinalis ♀ X S. Namaycush (Lake Ontario salmon trout)♂ produced F2 generation as well as back crosses with both parents.
Only female hybrids with eggs too large to pass through vent produced from S. fontinalis ♀ X Oncorhynchus tshawytscha (California salmon)♂. No eggs hatched when fertilized with S. fontinalis milt.
Also mentions without results a cross of S. fontinalis and Salmo gairdneri (California mountain trout).
Species identified in Bean (1889b).

Grieg, J.A. (1906) 114
Jager Fisker Foren.Tidskr., 67
Karusformet ørret

According to Dean (1962), misc. and unimportant.

Grimm, O.A. (1881) 115
Tr.Imp.Petrograd.Obshch.Estestvoispyt., 12(1)
A note concerning the cross-breeding of fish

Gould, W.R. (1966) 116
Copeia, (3):599-600
Cutthroat trout (Salmo clarkii Richardson) X golden trout (Salmo aquabonita Jordan) hybrids

Colour, meristic, and morphometric data presented on S. aquabonita ♀ X S. clarki ♂.

Haack, H. (1880) 117
Oesterr.Fisch.-Ztg., 1880:59
Die Fortpflanzungsfähigkeit der Bastarde

Haack, H. (1894) 118
Allg.Fisch.-Ztg., 19:280-1
Lachsbastarde auf der Schweizerischen Fischerei-Ausstellung in Zürich

Haacke, J.W. (1893) 119
Allg.Fisch.-Ztg., 18(14):210
Bastardirung der Forelle durch den Bachsaibling

According to Dean (1962), Salmo trutta (fario) X Salvelinus alpinus (salvelinus).

Haen, P.J. and F.J. O'Rourke (1968) 120
Nature, Lond., 217(5123):65-7
Protein and haemoglobins of salmon-trout hybrids

Hybrids of Salmo salar and S. trutta compared by electrophoresis for eye lens, muscle and serum proteins, and haemoglobins with both parents.

Haen, P.J. and F.J. O'Rourke (1969) 121
Proc.R.Ir.Acad., 68(B4):67-75
Comparative electrophoretic studies of soluble eye-lens proteins of some Irish freshwater fishes

Haen, P.J. and F.J. O'Rourke (1969a) 122
Proc.R.Ir.Acad., 68(B7):101-8
Comparative electrophoretic studies of the water soluble muscle proteins of some Irish freshwater fishes

Hagen, W. (1959) 123
Circ.U.S.Fish Wildl.Serv., (58)
Public fish culture in the United States, 1958. A statistics summary

Tables of distribution of splake from hatcheries in Michigan, Minnesota, New Hampshire, New York, and Wyoming.

Hallock, C. (1873) 124
For.Stream, 1:22
The introduction of hybrid fish

According to Dean (1962), misc. and unimportant.

Hansen, D.W. (1952) 125
Thesis, Ia. State College Library 55 p.
Life history studies of the trout of Pathfinder Reservoir, Wyoming
(Unpubl.MS)

According to Carlander (1959), Salmo clarki X S. gairdneri.

Hardy, E. (1961) 126
Salmon Trout Mag., (163):132-8
New salmon in Europe and research leading to the introduction of Pacific Oncorhynchus

Harris, G. (1969) 127
Trout Salmon Mag., 1969(86):31,33,35
Hybrids - success or failure?

Review of hybrids (Salmonidae) in general and the "sunbeam" (see Knowles, 1969) and the "ten-ton" trout in particular.
The sunbeam is a backcross of Salmo gairdneri ♀ X S. trutta ♂ to S. trutta ♂.
The ten-ton trout is reported hybrid of S. gairdneri and Oncorhynchus tschawytscha with exceptional hybrid vigor. (Angling Times November 28, 1968).

Harrison, A.C. (1961) 128
Piscator, 50:85-93
Tiger trout (Salmo trutta female X Salvelinus fontinalis male)

According to Carlander (1969), 55 hybrid trout in South Africa.

Hartman, G.F. (1956) 129
Thesis, University of British Columbia
A taxonomic study of cutthroat trout Salmo clarki clarki Richardson, rainbow trout Salmo gairdneri Richardson and reciprocal hybrids
(Unpubl.MS)

Fish bearing some of the distinguishing features of each specie suggested hybridization. Salmo clarki and S. gairdneri were reciprocally hybridized with no loss in viability.

Hayaguri, M. (1936) 130
Suisan Kenkyushi, 31(5):251-8.
Hybridization of trout
Issued also as Trans.Ser.Fish.Res.Board Can., (1167)(1968)

Reciprocal hybridization of Salvelinus pulvius, S. fontinalis, and Oncorhynchus masou. F_1 of S. pulvius and S. fontinalis backcrossed to S. fontinalis. The hybrids of S. pulvius and O. masou did not mature. The F_1 hybrids of S. fontinalis and O. masou were maturing at the time of writing (1936).

Henking, H. (1929) 131
Rapp.P.-v.Réun.Cons.Perm.Int.Explor.Mer, 61:1-99
Untersuchungen an Salmoniden mit besonderer Berücksichtigung der Art- und Rassenfragen. Teil 1.

Henking, H. (1931) 132
Rapp.P.-v.Réun.Cons.Perm.Int.Explor.Mer, 73:1-122
Untersuchungen an Salmoniden mit besonderer Berücksichtigung der Art- und Rassenfragen. Teil 2.

Alm (1955) reports that hybridization between S. salar and S. trutta was regularly carried out during the 20th century in the Baltic River Persante.

Hikita, T. and Y. Yokohira (1964) 133
Sci.Rep.Hokkaido Fish Hatchery, 18:57-65
Biological study on hybrids of the salmonoid fishes. A note of F1 hybrids between chum (Oncorhynchus keta) and pink salmon (Oncorhynchus gorbuscha)
Issued also as Trans.Ser.Fish.Res.Board Can., (1064)(1968)

Observations on reciprocal hybridization of O. keta and O. gorbuscha fry. Adults not returned at time of writing report. See Simon and Noble (1968) for a review.

Hitzeroth, H., et al. (1968) 134
Biochem.Genet., 1(3):287-300
Asynchronous activation of parental alleles at the tissue-specific gene loci observed on hybrid trout during early development

Hofer, B. (1909) 135
Halle am S, Verlag Schlüter & Mass. 558 p.
Die Süsswasserfische von Mittel-Europa

Alm (1955) reports that Hofer says only hybridization between Salmo salar females and S. trutta males is possible and not the opposite cross. "Übrigens lassen sich Forelleneier von Lachsmilch überhaupt nicht befruchten."

Hubbs, C.L. (1955) 136
Syst.Zool., 4(1):1-20
Hybridization between fish species in nature

Among the trout we find occasional intergeneric hybrids in nature as well as in culture. Most of these are between the native brook trout and the introduced brown trout. In the West the cutthroat and rainbow trouts, both belonging to the genus Salmo, live side by side with little or no crossing in many coastal streams but in the interior, where the cutthroat alone was native, the introduction of rainbows has repeatedly led to very extensive hybridization, and frequently to the elimination of the cutthroat, through a combination of hybridization and superior competition. The rainbow and golden trouts hybridize similarly. In the hatcheries many crosses have been produced between good species of chars, trouts, and salmons. Some of these produce fertile offspring, and by mating one hybrid with one of another cross, four species of the Pacific salmons have been combined in one individual (among the poeciliids we have thus combined as many as five species and twelve subspecies or races). One combination, between the brook trout and the lake trout, is being propagated in Canada with promise of use in fish management. The parental species were formerly classed as distinct genera, but in the current lumping spree both are put in Salvelinus - which action does not lessen the difference between the species.

Hunter, J.G. (1949) 137
Progr.Rep.Pac.Coast.Stn., (81):91-2
Occurrence of hybrid salmon in the British Columbia commercial fishery

Meristic and morphometric data on natural hybrids of Oncorhynchus gorbuscha and O. keta.

Inaba, D. (1953) 138
J.Tokyo Univ.Fish., 39(2):215-21
On the breeding and hybridization among the salmonoid fishes

Irving, R.B. (1953) 139
Thesis, Utah Stat.Agricultural College, 101 p. (MS)
Ecology of the cutthroat trout, Salmo clarki Richardson in Henry's Lake, Idaho

According to Carlander (1969), S. clarki X S. gairdneri.

Ismach, J. (1971) 140
Seattle Post-Intell., 1971, April 22:7
Salmon farm under experiment in sound

Reference to hybrids for hardiness and superior eating quality. See Mahnken, Novotny, and Joyner (1970).

Jones, J.W. (1947) 141
Proc.Zool.Soc.Lond., 117(4):708-15
Salmon and trout hybrids

Description of hybrids of S. salar ♀ and S. trutta ♂, including a backcross of same with a male S. salar, obtained from experiments from January 1934 to January 1938 at Fordingbridge by H.J. Skinner (1938) for Sir Ernest Wills.

Jones, J.W. (1959) 142
New York, Harper & Brothers, 192 p.
The salmon

Review of Jones (1947) and Alm (1955).

Jordan, D.S. (1906) 143
Science, N.Y., 23(585):434
Hybridization of Pacific salmon

A report of J.A. Richardson crossing all of the North American species of Oncorhynchus. He found the O. gorbuscha ♀ X O. nerka ♂ hybrid superior.

Jubb, R.A. (1961) 144
Bulawayo, Stuart Manning (PVT.) Ltd., 151 p.
An illustrated guide to the freshwater fishes of the Zambezi River, Lake Kariba, Pungwe, Sabi, Lundi and Limpopo Rivers

Kamyshnaia, M.S. (1961) 145
Nauchn.Dokl.Vyssh.Shk.(Biol.Nauki), 4:29-33
On the biology of the hybrid between chum and pink salmon: Oncorhynchus keta (Walbaum), Infras. autumnalis Berg X O. gorbuscha (Walbaum)--Family Salmonidae
Issued also as Transl.Ser.Fish.Res.Board Can., (403)(1962)

Hybrids of Oncorhynchus keta ♀ X O. gorbuscha ♂ in Sakhalin hatcheries having fast growth, early maturity, and excellent edible qualities.

Kamyshnaia, M.S. (1963) 146
Rybn.Khoz., (4)
Hybrids of chum-pink salmon in the rivers of the North

Kato, T. (1966) 147
Bull.Freshwat.Fish.Res.Lab., 16:59-65
Studies on the techniques of salmon- and trout culturing. 3. Growth and survival rate of Salvelinus pluvius, Salvelinus fontinalis and the hybrid, Salvelinus pluvius ♀ X Salvelinus fontinalis ♂
(In Japanese, English summary)

According to Suzuki and Kato (1966), F_1 hybrids, both male and female, were fertile.

Kawashima, K. and R. Suzuki (1968) 148
Bull.Freshwat.Fish.Res.Lab., 18(1):49-59
Lepidological study in some Japanese salmons
(In Japanese, English summary)

Hybridization of an unknown Oncorhynchus sp. with O. rhodurus and O. masou to show that the unknown species was actually O. rhodurus.

Kendall, W.C. (1921) 149
Trans.Am.Fish.Soc., 50:187-99
What are rainbow trout and steelhead trout?

Intraspecific hybridization of Salmo gairdneri. Reference to Day's work.

Kimura, S. (1961) 150
Bull.Biogeogr.Soc.Jap., 22(5):69-73
A new salmonid fish, Oncorhynchus iwame sp. nov., obtained Kyushu, Japan

Klein, W.D. (1966) 151
Progr.Fish-Cult., 28(3):146-51
The summer movement of hybrid and brook trout into an inlet stream

Hybrid trout (Salvelinus fontinalis X S. namaycush) and brook trout (Salvelinus fontinalis) were recovered in a trap in the inlet of Parvin Lake during the summer of 1962.

Klein, W.D. (1967) 152
Progr.Fish-Cult., 29(3):140-9
Evaluation of a pulsating direct-current shocking device for obtaining trout from a lake for population estimates.

Splake (Salvelinus namaycush ♀ X S. fontinalis ♂) are numerous in Parvin Lake, Colorado.

Kner, R. (1865) 153
Verh.Zool.-Bot.Ver.Wien, 15:199-202
Ueber Salmoniden-Bastarde
Issued also as Z.Gesamte Naturwiss., 27:453-4(Abstr.)

According to Dean (1962), Salmo trutta (fario and including Trutta lacustris) X Salvelinus alpinus (salvelinus) in Bärau near Gmunden, Austria.

Knoch, J. (1884) 154
Korresp.-Bl.Naturforsch., Riga, 27:1-13
Die kunstliche Zucht der Lachse, Lachsforellen, Forellen und der Bastarde derselben, sowie ihre Verpflanzung und Acclimatisation in den Flüssen Welikaja Pskowa und in dem Pleskauer See.

According to Dean (1962), Salmo trutta (fario) X Salvelinus alpinus (salvelinus).

Knowles, A. (1969) 155
Trout Salmon Mag., 1969(86):30, 32-3
How I bred the 'Sunbeam'

An account of the Fishery Officer for the West Somerset Water Board at Durleigh Reservoir hatchery's fast growing hybrid backcross of Salmo gairdneri ♀ X S. trutta to S. trutta ♂, named the "sunbeam". The F_2 generation of the sunbeam was 90% fertilized.

Also reported in the Angling Times May 22, 1969.

Kobayashi, H. (1963) 156
Cytologia, 28(4):365-75
Some cytological observations on fertilization in the cross between the dog-salmon and the pink-salmon
(From Sport Fish.Abstr., No. 87237)

The process of fertilization and the course of early cleavages in the cross between the dog-salmon (Oncorhynchus keta) and the pink-salmon (Oncorhynchus gorbuscha) and in its reciprocal cross were found to proceed in normal manner. No di- and polyspermic condition in insemination was found. The behaviour of the chromosomes during early cleavage of the hybrid egg showed nothing unusual. There was no lag or elimination of any chromosomes. There was no evidence to indicate that the spermatozoa acted as a parthenogentic agent.

Kobayashi, H. (1964) 157
Sci.Rep.Hokkaido Fish Hatchery, 18:67-71
Biological study of hybrids of the salmonid fishes. Cytological observation of fertilization in the cross between chum and pink salmon
Issued also as Transl.Ser.Fish.Res.Board Can., (1050)(1968)

The results of the cytological study on the fertilization in reciprocal crosses of Oncorhynchus keta and O. gorbuscha coincided with those of normal O. keta.

Koshida, H. (1926) 158
Suisan Kenkyushi, 35(7):180-3.
Ecology and hybridization of Masu. 1
Issued also as Transl.Ser.Fish.Res. Board Can., (1165)(1968)

Colour data on fertile hybrids of Oncorhynchus masou ♀ X Salmo mocrostoma ♂.

Koshida, H. (1926a) 159
Suisan Kenkyushi, 35(8):201-3
Ecology and hybridization of Masu. 2
Issued also as Transl.Ser.Fish.Res. Board Can., (1166)(1968)

Crosses of Salmo gairdneri ♀ X Salmo mocrostoma ♂ and S. gairdneri ♀ X Salvelinus fontinalis ♂ all died before reaching complete germination.

Krykhtin, M.L. (1962) 160
Izv.Tikhookean.Nauchno-Issled.Inst. Morsk.Rybn.Khoz.Okeanogr., 48
Data on the stream period of life of masu salmon

Kruse, T.E. (1959) 161
Fish.Bull.U.S.Fish.Wildl.Serv., 59(149):307-63
Grayling of Grebe Lake, Yellowstone National Park, Wyoming

In 1907 Salmo gairdneri and in 1912 S. clarki were planted in Grebe Lake. Since that time the two salmonid species have hybridized to such an extent that by 1952 no fish were found which were definitely pure strains of cutthroat or rainbow trout, but with a red slash on each side of the hyoid membrane. Hyoid teeth, a cutthroat characteristic, were present in all specimens examined. Body forms range from the typical elliptical shape of the cutthroat to the blunt, stocky, high-shoulder outline of the rainbow.

Kuznetsov, I.I. (1928) 162
Izv.Tikhookean.Nauchno-Promysl.Stn., 2(3):109
Some observations on the spawning of the Amur and Kamchatka salmons.
(In Russian)

It is worthwhile to note that the external species characteristics of certain fish sometimes were shown so indistinctly that experienced Japanese sorters made mistakes determining species and threw a chum in with the sockeye and vice versa. In such cases the determination of the species was made by us by the colour of the meat, which gave a sharp contrast from one species to another. The crossing of the characteristics of the fish (which has effect, one must suppose, in some degree or other, also on their fecundity), is probably the result of the chum and the sockeye spawning in the same place, giving a crossbreed. At any rate, the experience of crossbreeding on the Amur pink and summer chum points out the possibility of obtaining hybrids also between the chum and the sockeye or with the coho.

Leik, T.H. (1959) 163
Job completion reports in Q.Rep.Colo.Coop. Fish.Res.Unit, (5)

According to Martin (1960), "Ecology and life history, downstream migration studies, and creel census of hybrid trout in Parvin L., Colorado." (Splake)

Leik, T.H. (1960) 164
Thesis, Colorado State University, Fort Collins, 98 p.
Immature splake trout in a lentic environment
(Unpubl.MS)

An initial 2-year study dealing with morphological characteristics, growth and food habits, distribution, environmental requirements, and harvest of the hybrid between Salvelinus namaycush ♀ X S. fontinalis ♂ of S. mocrostoma ♀ X an undefined hybrid ♂ (could be Oncorhynchus masou ♀ X S. mocrostoma ♂ in Koshida, 1926a).

Lieder, U. (1956) 165
Z.Fisch., 4(7/8):589-94
Chromosomenstudien an Knochen fischen. 4. Cie Chromosomenverhaltnisse bei der Regenbogen-und Bachforelle und ihren Bastarden

The chromosome relationship between Salmo gairdneri and S. trutta and their hybrids support Svardson (1945).

Leopold, A. (1918) 166
Trans.Am.Fish.Soc., 47:101-2
Mixing trout in western waters

Discussion of planted trout hybridizing with each other and native trout. Mentions fishermen's reports of rainbow and a native black-spotted trout (species unknown to author) cross.

Leuckart, F.R. (1882) 167
Arch.Naturges., 48(2):309-15
Hybridism in fishes

Leuckart, F.R. (1882a) 168
Berlin, 9 p.
Ueber Bastardfische

According to Dean (1962), a review of Overbeck (1880).

Lewis, R.C. (1944) 169
Calif.Fish Game, 30(2):95-7
Selective breeding of rainbow trout at Hot Creek Hatchery.

p. 71 Needham and Gard, 1959

MacCrimmon, H.R. and J.S. Campbell(1969) 170
J.Fish.Res.Board Can., 26(7):1699-725
World distribution of brook trout, Salvelinus fontinalis

Liebmann and Reichenbach-Klinke state that, in some waters (in West Germany), brook trout cross with brown trout (Salmo trutta L.) and give rise to the sterile hybrid (Tigerfisch). (Personal communication, Liebmann, H., and H. Reichenbach-Klinke. 1967. Bayerische Biologische Versuchsanstalt München, 8 München 22, Federal Republic of Germany).

In Poland the high vulnerability of brook trout to angling pressure and natural hybridizing with brown trout limits its numbers. (Personal communication, Sakowicz, Stanislaw. 1967. Instytut Rybactwa Srodladowego Olsztyn-Kortowo, Poland).

In South Africa "male brook trout are now kept at the Jonkershoek Hatchery solely for crossing with the brown trout (S. trutta) to produce the 'Tiger Trout' hybrid." (Personal communication, Smith, D.F. 1967. Department of Nature Conservation, Stellenbosch, South Africa.)

MacCrimmon, H.R., B.L. Gots and J.S. Campbell (1971) 171
J.Fish.Res.Board Can., 28(3):452-6
World distribution of brook trout, Salvelinus fontinalis: further observations

Both brook trout and tiger trout (brown X brook hybrid) have been stocked in Rhodesian waters.

MacCrimmon, H.R., T.L. Marshall and B.L. Gots (1970) 172
J.Fish.Res.Board Can., 27(4):811-8
World distribution of brown trout, Salmo trutta: further observations

Brown trout is now naturalized in the mountain waters of the Oriental and Real ranges, and hybridization with the rainbow trout occurs (Terrazas, personal communication).

MacPhee, C. (1966) 173
Trans.Am.Fish.Soc., 95(4):381-7
Influence of differential angling mortality and stream gradient on fish abundance in a trout-sculpin biotope

At the end of a summer period, Svärdson (1949) found that a hatchery trough environment favoured the survival of alpine chars over char X trout hybrids and these hybrids survived better than brown trout when all three fish were mixed together.

Mahnken, C.V.W., A.J. Novotny and T. Joyner (1970) 174
Am.Fish Farmer, 2(1):12-5, 27
Salmon mariculture potential assessed

Hybrid of Oncorhynchus tschawytscha X O. gorbuscha used in experimental floating pens in Puget Sound.

Martin, N.V. (1960) 175
Res.Inf.Pap.Ont.Dep.Lands For.(Fish.), (7):12 p.
Annotated bibliography of the eastern brook trout X lake trout hybrid (Salvelinus fontinalis X Salvelinus namaycush)

Bibliography of splake through 1960.

Martin, N.V. and N.S. Baldwin (1960) 176
J.Fish.Res.Board Can., 17(4):541-51
Observations on the life history of the hybrid between eastern brook trout and lake trout in Algonquin Park, Ontario

In most features investigated, the hybrid trout has a greater affinity to the brook trout than to the lake trout. In angling, depth distribution, food, maturity, fecundity, and time and duration of spawning the hybrid trout is closer to the brook trout than the lake trout. Length-weight relationship, and place of successful spawning, are more similar to the lake trout. The hybrids grow faster than either parent, and school more strongly. Their spawning behaviour shows characteristics of each parent.

Martin, N.V. and D.C. Scott (1959) 177
Progr.Fish-Cult., 21(4):183-4
Use of Tricaine methanesulfonate (M.S. 222) in the transport of live fish without water

Movement of Salvelinus namaycush X S. fontinalis hybrids by air in Ontario.

Massaro, E.J. and C.L. Markert (1968) 178
J.Exp.Zool., 168(2):223-38
Isozyme patterns of salmonid fishes: evidence for lactate dehydrogenase polypeptides

From these observations, it has been concluded that salmonids are tetraploids. In our view, it seems most likely that they arose through allotetraploidization of a primitive hybrid ancestor.

Mather, F. (1876) 179
For.Stream, 6:69
Hybrid Salmonidae

According to Dean (1962), misc. and unimportant.

McCauley, R.W. and J.S. Tait (1970) 180
J.Fish.Res.Board Can., 27(10):1729-33
Preferred temperature of yearling lake trout, Salvelinis namaycush

The lake trout, like Oncorhynchus keta and brook X lake trout hybrid (Pearson, MS, 1952), belongs to type 5 of Zahn's classification characteristic of species having a moderate degree of stenothermality.

McPhail, J.D. (1961) 181
J.Fish.Res.Board Can., 18(5):793-816
A systematic study of the Salvelinus alpinus complex in North America

The validity of doubtful species pairs can be established if they occur sympatrically without mass hybridization. Occasional hybridization may occur, but as long as the hybrids are rare the species can be considered valid. In Karluk and Fraser Lakes S. malma and S. alpinus occur sympatrically. The evidence indicates that within these lakes hybridization between S. malma and S. alpinus rarely, if ever, occurs. From the data presented, S. alpinus and S. malma are considered as discrete species, each subject to geographic variation, which occur sympatrically in certain areas of Alaska with little or no hybridization.

Miller, R.B. (1949) 182
Alberta, Department of Lands and Forests, 139 p.
Preliminary biological surveys of Alberta watersheds, 1947-1949

According to Carlander (1969), Salmo clarki X S. gairdneri.

Miller, R.B. (1957) 183
J.Fish.Res.Board Can., 14(6):797-806
Have the genetic patterns of fishes have been altered by introductions or by selective fishing?

Changes in some salmonids may be assigned to introgressive hybridization, particularly where rainbow and cutthroat trout have been put together on the eastern slopes. In many cases, however, exotics have apparently failed to contribute to the gene pool of the resident population, and most hybrids, when they occur have been of low fertility. Limited review of other works.

Miller, R.R. (1950) 184
Occas.Pap.Mus.Zool.Mich.Univ., (529):42 p.
Notes on the cutthroat and rainbow trouts with the description of a new species from the Gila River, New Mexico

Miller, R.R. (1960) 185
Univ.Calif.Publ.Zool., (67):124 p.
Review of rainbow trout in Mexico and California with notes on the cutthroat series by Paul R. Needham and Richard Gard

Review of Needham and Gard (1959). Suggests that introduced trout may have hybridized with native stocks in Mexico. The native trout of the Gila River basin in New Mexico and Arizona are reduced through hybridization and introgression of characters.

Miller, R.R. and J.R. Alcorn (1943) 186
Trans.Am.Fish.Soc., 73:173-93
The introduced fishes of Nevada with a history of their introduction

Milne, D.J. (1948) 187
Thesis, McGill University Department of Zoology, Montreal, 101 p. (Unpubl.MS)
The growth, morphology and relationship of the species of Pacific salmon and the steelhead trout

Review of Foerster (1935).

Morrison, W.J. (1970) 188
Trans.Am.Fish.Soc., 99(1):193-206
Non-random segregation of two lactate dehydrogenase subunit loci in trout

Two of the five lactate dehydrogenase (LDH) subunit loci known to exist in salmonid fishes were obtained in heterozygous condition in the hybrid of lake trout (Salvelinus namaycush Walbaum) X brook trout (S. fontinalis Mitchill) and linkage tests were performed.

Morrison, W.J. and J.E. Wright (1966) 189
J.Exp.Zool., 163:259-70
Genetic analysis of three lactate dehydrogenase isozyme systems in trout: evidence for linkage of genes coding subunits A and B

Various crosses and backcrosses involving S. fontinalis and Salvelinus namaycush demonstrate that subunits A and B are each coded by different autosomal genes (LA and LB).

Comparison of patterns of S. fontinalis and S. trutta and their hybrid seems to indicate that two additional subunits are involved in a third series of five isozymes found in the skeletal muscle of each species examined."

Mulch, E.E. and W.C. Gamble (1954) 190
Pub.Ariz.Game Fish Dep., 19 p.
Game fishes of Arizona

The Arizona native trout, Salmo gila (Miller) "is native to the headwaters of the Gila River watershed and has hybridized with the rainbow trout. The fish is now (1954) restricted to the upper headwaters of Eagle Creek in Greenlee Country in its pure strain, and is probably also present in hybrid form in the Black and White Rivers and the steams of Mount Baldy."

Nall, G.H. (1930) 191
London, Seeley Services & Co.
Life of the sea trout

According to Jones (1959), Nall suggests that hybridization in nature may take place in small streams.

Neave, F. (1958) 192
Trans.R.Soc.Can., (3), 52 (5):25-39
The origin and speciation of Oncorhynchus

Most of the species of Oncorhynchus show a high degree of interfertility.

Needham, P.R. (1938) 193
Progr.Fish-Cult., 37:1-10, 43
Notes on the introduction of Mexican trout

p. 71 Needham and Gard, 1959

Needham, P.R. and R.J. Behnke (1962) 194
Progr.Fish-Cult., 24(4):156-8
The origin of hatchery rainbow trout

Introgression of Salmo clarki genes into S. gairdneri.

Needham, P.R. and R. Gard (1959) 195
Univ.Calif.Publ.Zool., 67(1):124 p.
Rainbow trout in Mexico and California with notes on the cutthroat series

Natural hybrids of Salmo gairdneri with S. aquabonita and S. clarki.

Needham, P.R. and R. Gard (1964) 196
Copeia, 1964(1):169-73
A new trout from Central Mexico: Salmo chrysogaster, the Mexican golden trout

Salmo chrysogaster believed derived by hybridization of a primitive S. gairdneri with a primitive S. clarki.

Nelson, J.S. (1965) 197
J.Fish.Res.Board Can., 22(3):721-53
Effects of fish introductions and hydroelectric development on fishes in the Kananaskis River system, Alberta

Reference to Gilmour (MS 1950) and stocking of Salmo clarki X S. gairdneri hybrids.

Nelson, J.S. (1968) 198
J.Fish.Res.Board Can., 25(2):409-14
Distribution and nomenclature of North American kokanee, Oncorhynchus nerka

Neresheimer, E. (1937) 199
Handb.Binnenfisch.Mittel-Eur., 3(5):219-370
Die Lachsartigen (Salmonidae)

New York (State), Commissioners of Fisheries of the State of New York (1879) 200
Rep.Comm.Fish.State N.Y., (11):7-10
Eleventh report of the Commissioners of Fisheries of the State of New York

According to Martin (1960), splake raised at Caledonia Hatchery, by 1991 had a small brood stock and plantings made but never followed up.

Nikoliukin, N.I. (1964) 201
Izv.Vses.Nauchno-Issled.Inst.Morsk. Rybn.Khoz.Okeanogr., 55
The hybridization of fish and its significance in acclimatization

According to Smirnov (1969), Nikoliukin believes salmon hybrids in general are rare.

Nyman, O.L. (1965) 202
Rep.Swed.Salmon Res.Inst., 1965(13):1-11
Variation of proteins in hybrids and parental species of fishes

Electrophoresis protein patterns were summations of the parental species, with few exceptions, in the hybrid bröding (Salvelinus alpinus and S. fontinalis). In splake (S. namaycush X S. fontinalis) the patterns were not distinguishable from S. fontinalis.

Nyman, O.L. (1966) 203
Rep.Swed.Salmon Res.Inst., 1966(3):1-6
Geographic variation in Atlantic salmon

All the diverging electrophoretic protein bands in the parental species were summed up in the F_1 hybrids of Salmo salar and S. trutta.

Nyman, O.L. (1967) 204
Rep.Inst.Freshwat.Res.Drottningholm, (47):5-38
Protein variation in Salmonidae

Nyman, O.L. (1970) 205
Trans.Am.Fish.Soc., 99(1):229-36
Electrophoretic analysis of hybrids between salmon (Salmo salar L.) and trout (Salmo trutta L.)

Analysis of hybrids of Piggins (1965).

Nümann, W. (1964) 206
Schweiz.Z.Hydrol., 26(1):102-46
Formenkreise der italienischen, jugoslawischen and adriatischen Forellen, zugleich ein Beitrag über den Wert einiger meristischen Merkmale für Art und Rasseanalysen

Behnke (1968) discusses Salmo marmoratus Cuvier hybridizing with S. trutta.

Ohno, S. et al. (1969) 207
Chromosomes Today, 2:139-47
Diploid-tetraploid relationship in clupeoid and salmonoid fish

In view of the drive toward the fusion of homologues demonstrated by these tetraploid salmonoid fish, the linkage of two gene loci which arose as a result of duplication by tetraploidy is expected.

Oshima, M. (1934) 208
Proc.Pac.Sci.Congr., 5(1933):3751-73
Life-history and distribution of the freshwater salmons found in the waters of Japan

Reciprocal crosses, backcrosses, and F_2 hybrids of Oncorhynchus masou and O. rhodorus. At the time, the cross performed extensively and great numbers of F_1 liberated into the streams.

Oshima, M. (1957) 209
Nire Shobo (Nire Book Company), Tokyo
Sakura-masu to Biwa-masu (Oncorhynchus masou and Oncorhynchus rhodurus)

Oshima, M. (1957a) 210
79 p. (in Japanese)
Studies on the dimorphic salmons Oncorhynchus rhodurus Jordan & McGregor, found in Japan and adjacent territories

According to Christie (1970), "Oshima (1957) demonstrated in hybridization experiments that the red spots of O. rhodurus are genotypic, and recessive to the O. masou coloration."

Oshima, M. (1959) 211
Dobutsugaku Zasshi, (Zoological Magazine) 68(7):259-62.
Occurrence of the natural hybrid between Oncorhynchus masou and Oncorhynchus rhodurus in the upper streams of Tenryu River.
Issued also as Transl.Ser.Fish.Res. Board Can., (1098)(1968)

Description of naturally produced hybrids between Oncorhynchus masou and O. rhodurus is given with a new name, Oncorhynchus hybridus sp.nov.

Oshima, M. (1969) 212
Dobutsugaku Zasshi, 68(7)
On the F_1 of Amago and Yamame of Sanpo up stream of Tenryu River

Terao and Hayashinaka (1961)

Overbeck, G. (1880) 213
Dtsch.Fisch.-Ztg., 67
Sind Bastardfische fruchtbar oder steril?
Issued also as Oesterr.Fisch.-Ztg., 1:36

According to Dean (1962), Salmo salar X S. trutta (fario) at Winkelsmuhle Düsseldorf.

Paust, G. (1955) 214
Sports Illus., July 11:36-9
Canada creates a great new trout.

According to Martin (1960), report of splake.

Pavlov, I.S. (1959) 215
Rybn.Khoz., 35(6):23-4
Experiments on the hybridization of Pacific salmon
Issued also as Transl.Ser.Fish.Res.Board Can., (263) (1960)

Meristic and morphological data on Oncorhynchus keta ♀ X O. gorbuscha ♂ hybrid, which returned in two years with an average weight in excess of O. keta.

Pearson, E. (1952) 216
Rep.Ont.Fish.Res.Lab., Univ.Toronto, 24 p. (Unpubl.MS)
The behaviour of a sample of hybrid trout (Salvelinus fontinalis X Cristivomer namaycush) in a vertical temperature gradient.

Pegington, C.J. and H. Rees (1967) 217
Chromosoma, Berl., 21(4):475-7
Chromosome size in salmon and trout

Measurements of a specific chromosome, S. of the salmon (Salmo salar) complement and of another, S, of the trout (Salmo trutta) complement in nuclei of parent species and of the hybrid show that the difference in size is maintained in hybrid nuclei.

Pennsylvania, State Commissioners of Pennsylvania, (1890-1901) 218
Annual reports of State Commissioners of Pennsylvania for years 1887-1901

According to Martin (1960), "Distribution lists for Corry Pennsylvania Hatchery. Total of 485,900 hybrids stocked in Pennsylvania streams between 1892 and 1900. Mostly fry, some 1 year and 2 year olds."

Peters, J.C. (1964) 219
Montana Fish and Game Department, Department of Fisheries, 76 p.(Mimeo)
D-J. Job Completion Rep. F-23-R-6 (jobs I-II).

Summary of calculated growth data on Montana fishes, 1948-61.

According to Carlander (1969), Salmo clarki X S. gairdneri.

Phillipps, W.J. (1923) 220
Salmon Trout Mag., 31:100-3
Hybridism of Salmo irideus and Salmo fario in Australasia
Issued also as N.Z.J.Sci.Technol., 5(2)

Reviews hybrids of Salmo gairdneri and S. trutta and traces the results of experiments in hybridization of same in Australasia.

Piggins, D.J. (1965) 221
Atl.Salmon J., Fall issue:3-5
Salmon and sea trout hybrids

Hybrids of Salmo salar ♀X S. trutta ♂ proved to show hybrid vigour for their first two years. Backcrosses of both sexes to both species have been successful.

Piggins, D.J. (1965 a) 222
Rep.Salmon Res.Trust, Irel., 1964:27-37
Salmon and sea trout hybrids

F.1 hybrids of salmon and sea trout (almost 5 years old at the end of 1964) reached an average length of 17.3" and were stripped for the third time. F.2 hybrids resulting from earlier strippings were reared in ponds and released into a land-locked lake where their average size as 1+ fish was 10", with some specimens of over 12" in length.

Piggins, D.J. (1966) 223
Rep.Salmon Res.Trust, Irel., 1965:7-9
Salmon X sea trout hybrids

Further inter-specific hybridization work was commenced in 1965, when crosses of male and female grilse with male and female sea trout were attended by normal results for fertilization and early incubation. Two years old F.2 hybrids numbering 700 were allowed to go to sea in April 1965. A total of 18 migratory and 10 non-migratory forms were recaptured during 1965. The

migratory forms resembled sea trout finnock and one was caught some 40 miles from this fishery. Limited rod-fishing for land-locked hybrids in Ballinlough resulted in a total catch of over 600 fish averaging 3/4-lb. in weight at two years of age, with occasional specimens of up to 1½ lbs.

Piggins, D.J. (1967) 224
Rep.Salmon Res.Trust, Irel., 1966:29-32
Further studies on the specific characteristics of brown trout and salmon-sea trout hybrids

There was approximately 50% survival to under-yearlings of salmon X sea trout hybrids obtained by fertilizing grilse ova with milt from sea trout in 1965. The complementary cross using sea trout ova and milt from grilse was a failure. Some 480, 2+ hybrid smolts were allowed to go to sea in 1966, of which 18 have been recaptured resembling sea trout finnock, as in 1965. Rod-fishing for land-locked hybrids continued in 1966 when the fish averaged 1½ lbs. in weight at 3+ years of age.

Piggins, D.J. (1971) 225
Salmon Research Trust Ireland
Salmon X sea trout hybrids (1960-1970)

A quite complete review of hybridization work in Ireland.

Plaza, M.L. Fuster de (1949) 226
Publ.Misc.Minist.Agric.Ganad., (319)
Hybridization between Salmo iridea (Gibb.) and Salvelinus fontinalis (Jord.)
Issued also as Transl.Ser.Fish.Res. Board Can., (13)

Description of hybrid between Salvelinus fontinalis female and Salmo gairdneri male. Mention of S. trutta and S. salar sebago, S. fontinalis and S. trutta hybrids.

Purkett, C.A., Jr. (1951) 227
Trans.Am.Fish.Soc., 80:251-9
Growth rate of trout in relation to elevation and temperature

Lengths of Salmo gairdneri X S.clarki hybrids.

Rasch, H.H. (1867) 228
Forh.Videnskapsselskap.Kristiania, 1866(1867):326-7
Resultatet af nogle af ham anstillede bastarderingsforsøg mellem forskjellige arter af ørretartede fiske

According to Dean (1962), misc. and unimportant.

Raveret-Wattel and Bartet (1883) 229
Bull.U.S.Fish Comm., 3:207-208
Reproduction of California salmon in the aquarium of Trocadero
Issued also as C.R.Hebd.Seances Acad.Sci., Paris 96(12):796-7

Oncorhynchus tshawytscha eggs milted with unspecified trout because of lack of ripe male salmon - the experiment did not succeed.

Rees, H. (1967) 230
Chromosoma, Berl., 21(4):472-4
The chromosomes of Salmo salar

A new chromosome number of 2n=58 given for S. salar and 2n=69 for S. salar X s. trutta hybrids.

Regier, H.A. (1966) 231
Progr.Fish-Cult., 28(1):3-17
A perspective on research on the dynamics of fish populations in the Great Lakes

Development of a deep-swimming strain of splake to avoid lamprey predation.

Richmond, F.G. (1919) 232
Salmon Trout Mag., 20:63-73
About rainbow trout

Phillipps (1923) reports that on page 72, "Personally I have met with no instances of brown trout and rainbow trout crossing. My attempts to cross them have always failed. I know water where the spawning-time of the latest brown trout overlaps that of the earliest rainbows; but I have never seen in this water any fish which looked like a hybrid, nor have I seen the two kinds on the reeds together."

Roberts, F.L. (1967) 233
Progr.Fish-Cult., 29(2):75-83
Chromosome cytology of the Osteichthyes

In experimental studies of hybridization, chromosome studies can be used to confirm that actual hybridization, rather than gynogenesis (that is, induction of cleavage by sperm without contribution of paternal chromosomes), has occurred. Further, chromosome analysis makes possible the proof of hybridization in the embryo or sac-fry, and also supplements nicely any morphological data that might be obtained from adult specimens.

Roberts, F.L. (1970) 234
Trans.Am.Fish.Soc., 99(1):105-11
Atlantic salmon (Salmo salar) chromosomes and speciation

Brief mention of Salmo salar and S. trutta, Oncorhynchus keta and O. gorbuscha hybrids.

Roosevelt, R.B. (1880) 235
Sci.Am., 42:263
Hybrid fish

Roosevelt, R.B. (1880 a) 236
Trans.Am.Fish Cult.Assoc., (9):8-13
Hybrids

Brief description of a hybrid of Salvelinus namaycush ♀ X S. fontinalis ♂.
Hybrid of S. fontinalis ♀ X Oncorhynchus tshawytscha ♂ (California salmon) produced only females with eggs too large to pass through vent. Artificially fertilized eggs with S. fontinalis milt failed to produce fry. Reciprocal crosses of S. fontinalis and Salmo gairdneri (California mountain trout (impregnated about 80% of the eggs used.
Also records crossing S. namaycush ♀ with an unspecified whitefish ♂ and S. fontinalis ♀ with an unspecified freshwater herring ♂. Results not recorded and no hybrids discussed.
Species identified in Bean (1889b).

Roosevelt, R.B. (1884) 237
Proc.Am.Assoc.Adv.Sci., 33:510-5

Rounsefell, G.A. (1962) 238
Fish.Bull.U.S.Fish.Wildl.Serv., 62(209): 235-70
Relationships among North American Salmonidae

A quite complete discussion and review of hybridization in Salmonidae.

Rurh, C.E. (1952) 239
Iowa State J.Sci., 27(3):55-77
Fish population of a mining pit lake, Marion County, Iowa

Runnstrom, S. (1950) 240
Rep.Inst.Freshwat.Res.Drottningholm, 31:5-18
Director's report for the year 1949

An early review of experiments of Alm (1955).

Sanders, B.G. (1964) 241
In Taxonomic biochemistry and serology, edited by C.A. Leone, New York, Ronald Press Co., pp.673-9
Electrophoretic studies of serum proteins of 3 trout species and the resulting hybrids within the Family Salmonidae

A comparative study of the blood serum of brown trout (Salmo trutta), brook trout (Salvelinus fontinalis), rainbow trout (Salmo gairdneri), and resulting hybrid specimens (tiger trout and brownbow trout) were analyzed electrophoretically for protein components, and the percentage of proteins in each fraction was determined.

Sano, S. and H. Eguchi (1936) 242
Suisan Fukajyo Fukunei Sho, Showa 11 nen:13.
Interspecific hybridization among salmonid fishes
Issued also as Transl.Ser.Fish.Res. Board Can., (1164)(1968)
Hybrids of Oncorhynchus keta, O. nerka, O. masou, Salmo gairdneri, and Salvelinus fontinalis.

Scheuring, L. (1930)
Bad.Fisch.-Ztg., 7:33
Beobachtungen über die Erbrütung und Aufzucht von Lachsen und Bastarden zwischen Lachs und Bachforelle

Alm (1955) records that this paper was not available in Sweden, but referred to in other papers. Scheuring emphasized that S. salar female X S. trutta male gave far better results than its reciprocal, which had a larger number of malformations and more extensive yolk sac disease. The largest reached 20 cm. after one year in a pond.

Scott, W.B. (1956)
Toronto, Royal Ontario Museum, 7 p.
Wendigo the hybrid trout

An account of splake (Salvelinus namaycush ♀ X S. fontinalis ♂).

Se, Huan, and Yuan (1959)
Acta Hydrobiol.Sinica, 2:215-20
Lenok and taimen and their natural hybrids in the Hailungian basin (In Chinese, Russian summary)

According to Behnke (1968), natural hybrids of Brachymystax lenok and Hucho taimen (Pallas) from the Amur River system in China.

Sequin, L.R. (1954)
Quebec, Game and Fisheries Department
The "Splake" In Ephemerides of the Biological Bureau 1(1):21-2

Martin (1960) states, "in 1953 anglers caught 300 F_1 and F_2 hybrids raised in Eastern Townships Fish Hatchery."

Seguin, L.R. (1956)
In Booklet of Game and Fisheries Department, Province of Quebec
Habits and rearing methods of Quebec trout

According to Martin (1960), "1944 - 700 splake fingerlings planted in Lake Lyster, Quebec. General description appearance habits, photographs."

Seguin, L.R. (1957)
Trans.Am.Fish.Soc., 86:136-43
Scientific fish culture in Quebec since 1945

Artificial hybridization using the following species: Salvelinus fontinalis, S. namaycush, S. alpinus marstoni, Salmo gairdneri, S. trutta, and S. salar. The best growth was for S. fontinalis ♀ X S. alpinus marstoni ♂.

Shapovalov, L., W.A. Dill and A. Cordone (1959)
Calif.Fish Game, 45(3):159-80
A revised check list of the freshwater and anadromous fishes of California

Planting of splake (Salvelinus namaycush ♀ X S. fontinalis ♂) in Sierra County.

Simon, R.C. and R.E. Noble (1968)
Trans Am.Fish.Soc., 97(2):109-18
Hybridization in Oncorhynchus (Salmonidae). 1. Viability and inheritance in artificial crosses of chum and pink salmon

Survival and fertility are substantial in first generation hybrids. Morphological features in the F_1 are either like one parent, unlike either parent, or intermediate. Failure of hybrids to be intermediate in some parental attributes is contrasted to earlier reports. Hybrid fertility is equated to persistence of parental traits in the phenotype of the F_1. Multiple and additive gene systems are assumed to be operative wherein dominance is suspected in two characteristics. Viability data are provided on F_1, F_2, reciprocal, and backcross hybrids. Morphological descriptions contained provide some basis for recognizing natural chum-pink hybrids.

Skinner, H.J. (1938)
Field, 1938, 30 July
Salmon and trout hybrids

Slastenenko, E.P. (1953)
Rev.Soc.Mex.His.Nat., 14(1-4):71-6
El crecimento en los hibridos de Salvelinus fontinalis y Salvelinus namaycush.

Growth study of the hybrid.

Slastenenko, E.P. (1953)
Rev.Soc.Mex.Hist.Nat., 14
Estudio de hibridos artificiales entre Salvelinus fontinalis Mitchill y S. namaycush Walbaum

253

Slastenenko, E.P. (1954)
J.Fish.Res.Board Can., 11(5):652-9
The relative growth of hybrid char (Salvelinus fontinalis X Cristivomer namaycush)

Hybrid char from Banff were intermediate between the two parental species, lake trout and eastern brook trout, in respect to relative growth of some characters; in others they approximated one or other of the parent species.

254

Slastenenko, E.P. (1956)
Istanbul Univ.Fen Fak Mecm, (B), 21(3)
Hybridization as a factor of evolution

Martin (1960) states, "Reference to Slastenenko (1964). Lake trout X brook trout hybrids had intermediate characters and characteristics of one of the parental species."

255

Slastenenko, E.P. (1956)
Rev.Soc.Mex.Hist.Nat., 17:63-84
A world list of natural hybrids of fishes

256 A quite complete review of hybridization of Salmonidae in the USSR.

Smirnov, A.I. (1950)
Rybn.Khoz., (4)
Following up on chum and pink hybrids

257

Smirnov, A.I. (1953)
Dokl.Akad.Nauk SSSR, 91(2):409-12
Some characteristics of the interspecific hybrid between autumn chum salmon and pink salmon, Oncorhynchus keta (Walbaum) infraspecies autumnalis Berg X O. gorbuscha (Walbaum), family Salmonidae
Issued also as Transl.Ser.Fish.Res. Board Can., (957)(1967)

High percentage of fertilization and heterosis of the hybrid.

258

Smirnov, A.I. (1953a)
Tr.Soveshch.Vopr.Lososev.Khoz.Dal'nego Vostoka, 1953:94-110.
Problems of rationalization of the biotechnique of salmon breeding on Sakhalin
Issued also as Transl.Ser.Fish.Res.Board Can., (1110)(1968)

259

Reciprocal hybrids of Oncorhynchus keta and Salvelinus leucomaenis, O. gorbuscha and S. leucomaenis, and O. keta ♀ X O. gorbuscha ♂.

Smirnov, A.I. (1959)
Priroda, Mosk., 6:98-100
Intergeneric hybridization of Pacific salmon
Issued also as Transl.Ser.Fish.Res.Board Can., (251)

260

Hybrids of Salvelinus leucomaenis X Oncorhynchus kisutch result in cyclops-like embryos.

Smirnov, A.I. (1969)
In Genetica, selektsiia i ribridizatsiia Ryb.Akad.Nauk SSSR, Ichthiol.Komm., Moskva, pp. 139-59
Hybrids of Pacific salmon of the genus Oncorhynchus, characteristics of their growth and development and prospects of utilization

261

Smith, C.E. (1971)
J.Fish.Res.Board Can., 28(1):112-3
An undifferentiated hematopoietic neoplasm with histologic manifestations of leukemia in a cutthroat trout (Salmo clarki)

262

Dunbar (1969) reported lymphosarcomas in three brook trout, Salvelinus fontinalis, and two hybrid splake (brook trout X lake trout). He suggested that the tumours were most likely of thymic origin.

Smith, E. (1915)
Trans.Pac.Fish.Soc., 1:71-8
Salmon hybridization

263

Reciprocal crosses of Oncorhynchus tschawytscha and O. kisutch with growth and colour data.

Smith, S.H. (1968)
J.Fish.Res.Board Can., 25(4):667-93
Species succession and fishery exploitation in the Great Lakes

Splake in Ontario.

Soguri, M. (1936)
Suisan Kenkiu-shi, 31:251-8 (in Japanese)
On hybrids among trouts

According to Suzuki and Kato (1966), "Soguri (1936) who obtained firstly the artificial F_1 hybrids of Salvelinus pluvius ♀ X Salvelinus fontinalis ♂ reported that their females were fertilizable, while males were sterile."

Soldwedel, R.H. (1968)
N.J. Outdoors, 18(1):20
Brookbows

According to Atz (1971), natural reciprocal hybrids of Salvelinus fontinalis and Salmo gairdneri.

Solman, V.E.F. (1951)
Trans.North Am.Wildl.Conf., 16:225-33
The creel census in the National Parks of Canada

According to Martin (1960), use of splake in mountain lakes, first plant in 1950.

Solman, V.E.F., J.-P. Guerrier and W.C. Cable
Trans.North Am.Wildl.Conf., 17:226-34
Why have fish hatcheries in Canada's national parks?

According to Martin (1960), splake have faster growth and acclimatize better to cold water than brook trout. The splake spawn in late October on gravel bottoms like speckled trout.

Sømme, J.D. (1941)
Oslo, J. Dybwads Forlag, 591 p.
Orretboka

Sowards, C.L. (1959)
Progr.Fish-Cult., 21(4):147-50
Experiments in hybridizing several species of trout

264 The F_1 generation of brookinaw was obtained by crossing a brook trout female and a lake trout male. The hatching success was 73 percent, with good survival. Hatching success for 2 lots of the F2 generation averaged 68 percent. Hatching success of a back-cross with a brook trout male was 94.1 percent, and that of a back-cross with a brook trout female was 82.2 percent.

265 A cross between a brookinaw female and a brown trout male yielded a hatching success of 4.8 percent; a cross between a brown trout female and a brookinaw male yielded a hatch of 32.2 percent.
The hatching success of a cross between a lake trout female and a brook trout male was 38.5 percent.

Stenton, J.E. (1950) 271
266 Can.Fish Cult., 6:20-2
Artificial hybridization of eastern brook trout and lake trout

Data on reciprocal crosses of Salvelinus namaycush and S. fontinalis.

Stenton, J.E. (1952) 272
267 Can.Fish Cult., 13:15-21
Additional information on eastern brook trout X lake trout hybrids

Meristic and morphological data on fertile hybrids of Salvelinus namaycush ♀ X S. fontinalis ♂.

Stenton, J.E. (1953) 273
268 North.Sportsman, 8(5):12-3
Anglers will have a new opponent

Martin (1960) states, "Popular account of Stenton's work in Alberta based on Stenton (1950, 1952)."

Stokell, G. (1949) 274
Rec.Canterbury Mus., 5:209-12
The numerical characters of five hybrid trout

269 Meristic data on hybrids of Salmo gairdneri and S. trutta.

Strawn, K. (1958) 275
270 In Handbook of biological data, 1 p. table
Optimum and extreme temperatures for growth and survival: various fishes.

According to Carlander (1969), splake.

Suchetet, A. (1888)
Rev.Quest.Sci., 12:188-97
L'hybridete dans la nature. Fishes

Suzuki, R. (1965)
Jap.J.Ichthyol., 13(1/3):64-8
Hybridization experiments in cyprinid fishes. 8. Two kinds of reciprocal crosses, Pseudogobio esocinus X Pseudorasbora parva and Biwia zezera X Pseudorasbora parva

Brief reference to early work in hybridization of Salmonidae.

Suzuki, R. (1966)
Bull.Jap.Soc.Sci.Fish., 32(8):677-88
Thremmatological aspects on the hybridization in fish
(In Japanese)

No translation available at this time, but reference to quite a few reports on hybridization in English.

Suzuki, R. (1968)
Bull.Freshwat.Fish.Res.Lab., Tokyo, 18(2):113-55
Hybridization experiments in cyprinid fishes. 11. Survival rate of F1 hybrids with special reference to the closeness of taxonomical position of combined fishes

Interordinal cross with spermatozoa of Salmo gairdneri and eggs of female Tribolodon hakonensis did not develop at all.

Suzuki, R. (1969)
Bull.Freshwat.Fish.Res.Lab., Tokyo, 19(1):17-24
Notes on the edematous fry in fish hybrids

Very brief mention of hybrids in Salmonidae.

Suzuki, R. and T. Kato (1966)
Bull.Freshwat.Fish.Res.Lab., Tokyo, 16(2):83-90
Hybridization in nature between salmonid fishes, Salvelinus pluvius X Salvelinus fontinalis

Meristic and colour characteristics were intermediate of the parental species in natural and artificial hybrids of this cross.

Svärdson, G. (1945)
Rep.Inst.Freshwat.Res.Drottningholm, 23:1-151
Chromosome studies on Salmonidae

According to Alm (1955), Svärdson claims that hybrids of S. salar and S. trutta are possible only when the salmon is the mother. Alm believes Svärdson got the idea from Hofer (1909) without ever attempting any hybridization experiments himself.

Svärdson, G. (1949)
Rep.Inst.Freshwat.Res.Drottningholm, 29:108-11
Competition between trout and char, (Salmo trutta and S. alpinus)

According to MacPhee (1966), Svärdson "found that a hatchery trough environment favoured the survival of alpine chars over char X trout hybrids and these hybrids survived better than brown trout when all three fish were mixed together."

Tait, J.S. (1970)
J.Fish.Res.Board Can., 27(1):39-45
A method of selecting trout hybrids (Salvelinus fontinalis X S. namaycush) for ability to retain swimbladder gas

A method was developed for selecting hybrid trout for deep-swimming ability, for use in a breeding program to combine in one strain the early-maturing character of brook trout (Salvelinus fontinalis) with the deep-swimming ability of lake trout (S. namaycush). The method involves testing hybrids in pressure tanks and selecting individuals that, like lake trout, retain most of their swimbladder gas during the test period. For a sample of F_2 hybrids the range of pressures at which the fish floated when anaesthetized was almost entirely between the medians for samples of the two parent species. Successive tests of marked individuals showed good repeatability of floation measurements. The method is concluded to be reliable for large-scale selection of fish with ability to retain swimbladder gas.

Tanner, H.A. (1959) 285
Colo.Outdoors, 8(4):12-5
New Trout for Colorado?

Discussion of trout hybrids, relative success of various crosses, and use of selective breeding to get desirable characteristics.

Taylor, D.M. (1969) 286
Ocean Ind., 4(12):43-9
Japan and the sea

Reference to Ryo Suzuki, "by cross-breeding rainbow trout and salmon, he has produced mutants that are healthy, have long lives and are a delight for fish lovers. But like most mutants, they cannot reproduce." Salmon not identified.

Terao, A. (1935) 287
Jap.J.Genet., 9(3):183
Cross between the cod, Gadus macrocephalus Tilesius♀ and the salmon, Oncorhynchus keta (Walbaum)♂

Description of fry with maternal influence dominant.

Terao, T. and H. Hayashinaka (1961) 288
Sci.Rep.Hokkaido Fish Hatchery, 16:51-62
On the artificial hybridization among the salmonid fishes. 1.
Issued also as Transl.Ser.Fish.Res.Board Can., (1047)(1968)

Reciprocal crosses of Oncorhynchus keta, O. nerka, and O. masou. The best results of fertilization, hatching and growth were obtained from reciprocal crosses of O. keta and O. nerka. Good results were also obtained from the hybrid between O. keta ♀ X O. masou♂. Observations on the growth of two-year-old hybrids of O. keta♀ X O. nerka♂ and one-year-old O. nerka♀ X O. keta♂ after lake growth. Meristic and morphometric data.

Terao, T. et al. (1963) 289
Sci.Rep.Hokkaido Fish Hatchery, 18:45-58
Studies on the interspecific salmonid hybrids between chum salmon, Oncorhynchus keta (Walbaum) and kokanee salmon, Oncorhynchus nerka var. adonis (Jordan et McGregor). 1. Survival and growth from fertilized eggs to fry
Issued also as Transl.Ser.Fish.Res. Board Can., (1060)(1968)

Reciprocal crosses produced hybrids which compared favourably with their parents in hatching rate and grew faster in their first year.

Terao, T. et al (1964) 290
Sci.Rep.Hokkaido Fish Hatchery, 19:43-63
Studies on the interspecific salmonid hybrids between chum salmon Oncorhynchus keta (Walbaum) and kokanee salmon O. nerka var. adonis (Jordan et McGregor). 2. Transplantations of salmonid hybrids to Lake Shikotsu and Lake Okotampe
Issued also as Transl.Ser.Fish.Res.Board Can., (1061)(1968)

Terao, T. et al. (1965) 291
Sci.Rep.Hokkaido Fish Hatchery, 20:29-36
Studies on the interspecific salmonid hybrids between chum salmon Oncorhynchus keta (Walbaum) and kokanee salmon Oncorhynchus nerka var. adonis (Jordan et McGregor). 3. On some external characteristics and fertility of F_1 hybrids
Issued also as Transl.Ser.Fish.Res. Board Can., (1073)(1968)

Reciprocal hybrids of O. keta and O. nerka were backcrossed to O. keta and were superior to F_2 hybrids.

Terao, T. et al. (1966) 292
Sci.Rep.Hokkaido Fish Hatchery, 21:13-41
Studies on the interspecific salmonid hybrids between chum salmon, Oncorhynchus keta (Walbaum) and kokanee salmon, Oncorhynchus nerka var. adonis (Jordan et McGregor). 4. Morphological comparison of variation in some meristic characters of hybrids (F_1) and parent species
Issued also as Transl.Ser.Fish.Res.Board Can., (1074)(1968)

It was found from the present study that each of the reciprocal hybrids displays having the respective proper meristic characters irrespective of both age and environment. Consequently, it may be said that these characters of the hybrids are being controlled more strongly by some hereditary factors rather than by the secondary ones.

Terao, T. et al. (1968) 293
Sci.Rep.Hokkaido Fish Hatchery, 23:23-34
Studies on interspecific salmonid hybrids between chum salmon, Oncorhynchus keta (Walbaum) and kokanee salmon, Oncorhynchus nerka var adonis (Jordan et McGregor. 6
(In Japanese, English summary)

Tokui, T. (1969) 294
Sankana to Tamago, 20(3):3-8
Masu salmon (Oncorhynchus masou) transplanted from Hokkaido to Canada
Issued also as Transl.Ser.Fish.Res. Board Can., (1504)(1970)

Mention of hybrid of the masu salmon (Oncorhynchus masou) and the Amemasu (Salvelinus leucomaenis) being released in Numasawa Marsh, Fukushima Prefecture.

Tsuyuki, H. and E. Roberts (1965) 295
J.Fish.Res.Board Can., 22(3):767-73
Zone electrophoretic comparison of muscle myogens and blood proteins of artificial hybrids of Salmonidae with their parental species

Starch-gel zone electropherograms the muscle myogen and blood hemoglobins and disc electropherograms of the serum proteins of a number of artificial hybrids involving the Salmo, Salvelinus, and Cristivomer genera are compared to their respective parental species.

Tsuyuki, H., E. Roberts and W.E. Vanstone (1965) 296
J.Fish.Res.Board Can., 22(1):203-13
Comparative zone electropherograms of muscle myogens and blood hemoglobins of marine and freshwater vertebrates and their application to biochemical systematics

The myogen patterns of Anoplopoma fimbria from different areas have a centre pattern including all the zones of the other two patterns. This is parallel to the results shown by artificially produced F_1 hybrids of the salmonid family (Tsuyuki, unpublished data) ... extensive natural hybridization may be taking place within A. fimbria as was also found in the genus Oncorhynchus in an unexpectedly greater frequency than was formerly thought.

Tsuyuki, H. et al. (1965) 297
J.Fish.Res.Board Can., 22(1):215-7
The species specificity and constancy of muscle myogen and hemoglobin electropherograms of Oncorhynchus

Instances of myogen pattern variations observed in other species of fish as well as the occasional samples of Oncorhynchus have been discussed in relation to natural and artificial hybridization studies (Tsuyuki et al., 1965). The results of this study emphasize the usefulness of myogen and hemoglobin patterns for phylogenetic purposes.

Tuunainen, R. (1967) 298
Fisktidskr.Finl., 1967(1):1-4
On the relationship of salmon fish
Issued also as Transl.Ser.Fish.Res. Board Can., (1476)(1970)

Salmo gairdneri and S. clarki easily hybridized and genetically very close to each other.

Van Oosten, J. (1957) 299
Proc.Assoc.Midwest Game Fish.Comm., 24:17-22
Exotics and hybrids in fish management

A comprehensive report of general hybridization.

Vincent, R.E. (1960) 300
Trans.Am.Fish.Soc., 89(1):35-52
Some influences of domestication upon three stocks of brook trout (Salvelinus fontinalis Mitchill)

Backcross of a male splake to female brook trout used in connection with another project.

Vladykov, V.D. (1954) 301
J.Fish.Res.Board Can., 11(6):904-32
Taxonomic characters of the eastern North American chars (Salvelinus and Cristivomer)

Vladykov, V.D. (1963) 302
Trans.R.Soc.Can., (4);1(3):459-504
A review of salmonid genera and their broad geographical distribution

Brief summary of hybrids in Salmonidae.

Vogel, P. (1898) 303
Bautren, E. Hübner, pp.308, 311
Ausführliches Lehrbuch der Teichwirthschaft

Cited by Chamberlain (1907) for a discussion of hybridization of trout

Wales, J.H. (1957) 304
Species Bookl.Calif.Fish Game, (6):56 p.
Trout of California

Mention of splake, natural tiger trout, and natural hybrids of rainbow and golden trout and rainbow and cutthroat.

Washington State Department of Fisheries (1964) 305
Rep.Wash.State Dep.Fish., 1964:109-11
Hybrid chum-pink studies

Oncorhynchus gorbuscha X O. keta hybrids returned to Hood Canal hatchery.

Webster, D.A. (1955-1971) 306
Adirondack League Club fishery management reports for 1954-1970

Planting of tiger trout (Salmo trutta ♀ X Salvelinus fontinalis ♂) and splake Salvelinus namaycush ♀ X S. fontinalis ♂) including backcrosses of splake to S. fontinalis ♀ in New York.

Whitmore, D. and E. Goldberg (1969) 307
Physiol.Chem.Phys., 1969(1):339-47
Molecular heterogeneity of alkaline phosphatase in trout

Tiger trout (Salmo trutta X Salvelinus fontinalis used.

Wilimovsky, N.J. and W.O. Freihofer (1957) 308
Spec.Sci.Rep.U.S.Fish.Wildl.Serv., (209)
Guide to literature on systematic biology of Pacific salmon

Lists eleven authors of reports on hybridization.

Williscroft, S.N. and H. Tsuyuki (1970) 309
J.Fish.Res.Board Can., 27(9):1563-7
Lactate dehydrogenase systems of rainbow trout - evidence for polymorphism in living and additional subunits in gills

Brief review of LDH in splake.

Winge, O. and E. Ditlevsen (1948) 310
C.R.Lab.Carlsberg(Ser.Physiol.), 24(23):317-37
A study on artificial hybrids between salmon (Salmo salar) and brown trout (Salmo trutta)

Withler, F.C. (1969) 311
Manuscr.Ser.Fish.Res.Board Can., (1014):36 p.
Visit to Hokkaido hatcheries, 1964

Reference to Sano and Hikita hybrid work.

Withler, F.C. and R.B. Morley (1970) 312
J.Fish.Res.Board Can., 27(12):2197-214
Sex-related parental influences on early development of Pacific salmon

Extensive study of reciprocal hybrids of Oncorhynchus keta, O. gorbuscha, and O. nerka.

Wooding, F.H. (1958) 313
London, Collins Press
The anglers' book of Canadian fishes

According to Martin (1960),"a general history of splake and angling qualities."

Wright, J.E., Jr. (1955) 314
Progr.Fish-Cult., 17(4):172-6
Chromosome numbers in trout

Chromosome relationship to hybridization.

Wright, J.E., Jr. and K. Buss (1958) 315
Proc.Int.Congr.Genet., 10(2):322
Barriers to artificial hybridization of certain species of the Salmonidae

Failings in some hybrids.

Zalsman, P.G. (1914) 316
Trans.Am.Fish.Soc., 43:161-3
Experiments in fish culture

Crosses of Salvelinus fontinalis, Salmo trutta, Silver or Lake Tahoe (Salmo clarki?), S. gairdneri, and Salvelinus namaycush.

Zilliox, R.G. (1957) 317
N.Y.State Conserv., 2(5):26-7
New trout for none

Martin (1960) states, "General notes on planting in New York. Use in reclaimed waters. Combined plantings with rainbow trout."

Anon (1872) 318
Ausland, 45:1104
Ein neuer Bastard-Lachs (Salmo)

According to Dean (1962), miscellaneous and unimportant.

Anon (1952) 319
North.Sportsman, 7(4):15, 27

According to Martin (1960), "Brief mention of Ontario Department of Lands and Forests and Canadian Wildlife Service hybridizing lake trout and brook trout."

Anon (1954) 320
North.Sportsman, 9(2):15
Splake hybrids

Martin (1960) states, "General comments on history and potential of hybrid. Popular account."

Anon (1957) 321
North.Sportsman, 12(5):32
"Splake" may be taken this year by angling

According to Martin (1960), "Short notes on limits, size, season."

Anon (1961) 322
Wis.Conserv., 140:5
Record splake

Anon (1961) 323
Commer.Fish.Rev., 23(1):17
Sixth species of salmon caught in Alaskan waters

Behnke, Koh, and Needham (1962) speculate that the Oncorhynchus masou caught could have been a Russian hybrid of O. keta X O. gorbuscha.

Anon (1962) 324
Rep.Ont.Dep.Lands For.Res.Branch Sec.(Fish.), (44):61 p.
Status of fisheries research projects for the year 1961

According to Regier (1966), J.S. Tait and F.E.J. Fry have worked on a selection programme to obtain a deep-swimming strain of splake.

Anon (1966) 325
Mich.Conserv., 35(5):32
Birth of the splake maybe?

F_2 hybrids of Salvelinus namaycush ♀ X S. fontinalis ♂ in The First Annual Report of Fish Culture by Michigan's Fish Commissioners (1880)

Anon (1968) 326
Rep.Freshwat.Biol.Assoc., (36):144 p.

According to Atz (1971), "Natural reciprocal hybrids of Salvelinus fontinalis and Salmo trutta.

Anon (1969) 327
Fisherman, 32(26):12
Scientists develop hybrid between Siberian and humpback salmon

Two photographs of hybrids of Oncorhynchus keta and O. gorbuscha developed at the Kalinin fish breeding plant on Sakhalin Island (USSR).